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Palace of Horticulture and Dome, Panama Pacific Exposition

By A. W. Earl and Thomas F. Chace*

The recently completed Palace of Horticulture at the Panama-Pacific Exposition has a dome that ranks among the largest steel domes and in fact among the largest domes of any kind in the world. The size of this structure, coupled with a desire to keep the framework light and airy in conformity with the character of the building, made a careful study of the design well worth while. Many interesting problems arose in the course of this study. The character of the framing and the methods of analysis by which the designs were worked out will be set forth in future articles by the authors. For the present a brief description of the building is given.

The Palace of Horticulture is rectangular in plan, approximately 660x300 ft., and covers an area of 4½ acres.

The eastern or main portion is square in plan and forms the base for the imposing glass-covered dome, the salient feature of the design. The dome is a hemisphere 152 ft. in diameter, resting upon a cylinder of the same diameter and 25 ft. high. It is surmounted by an architectural staff motive in the form of an immense flower basket. The extreme height from the ground to the top of the basket is 186 ft. Rising from the low roof and intersecting the large dome are eight small glazed half-domes, and at the four corners of the square are four octagonal domes of timber construction. The main entrances on the north, east and south sides are accentuated by elliptical domes built of wooden lattice-work. On either

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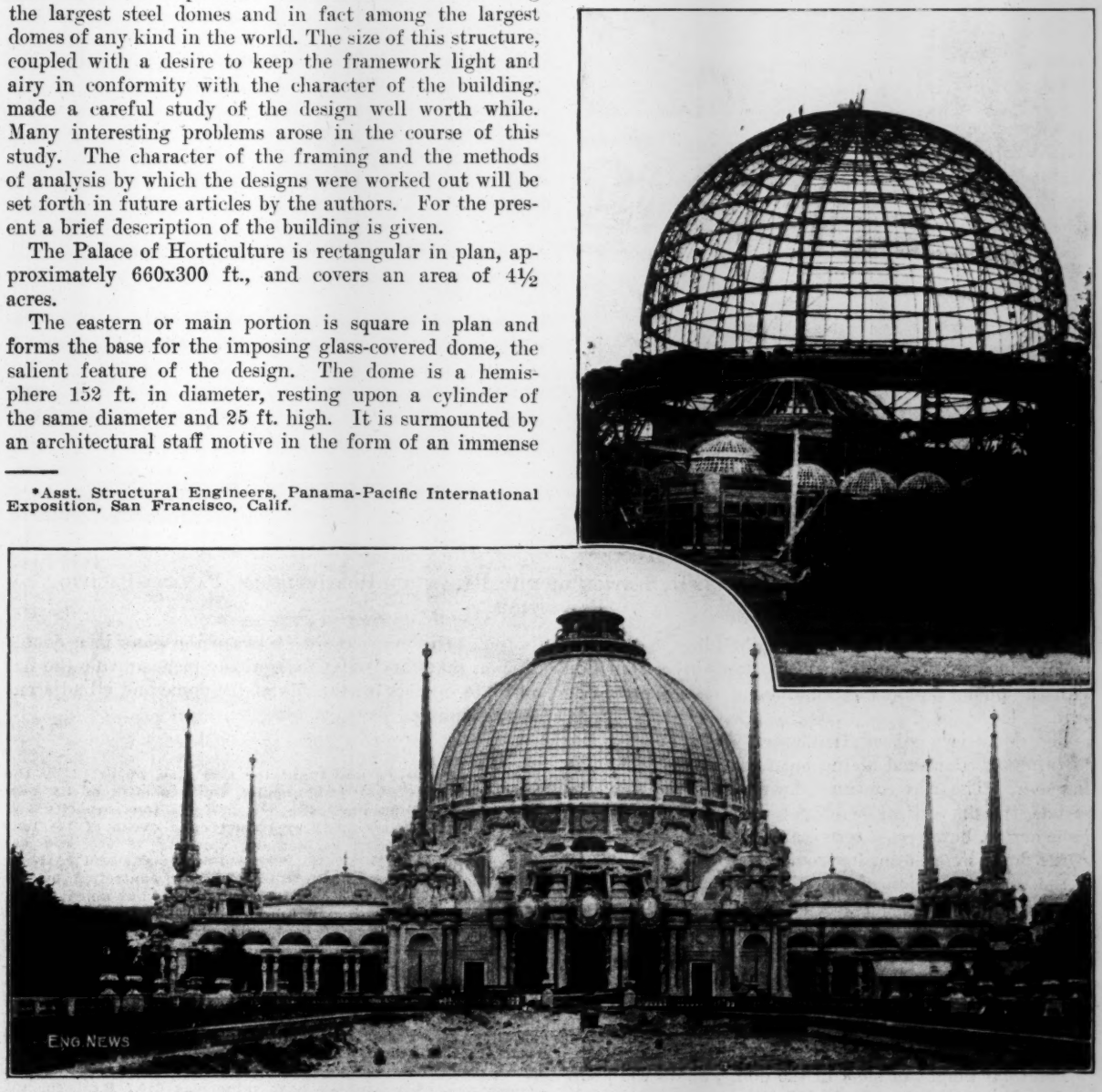


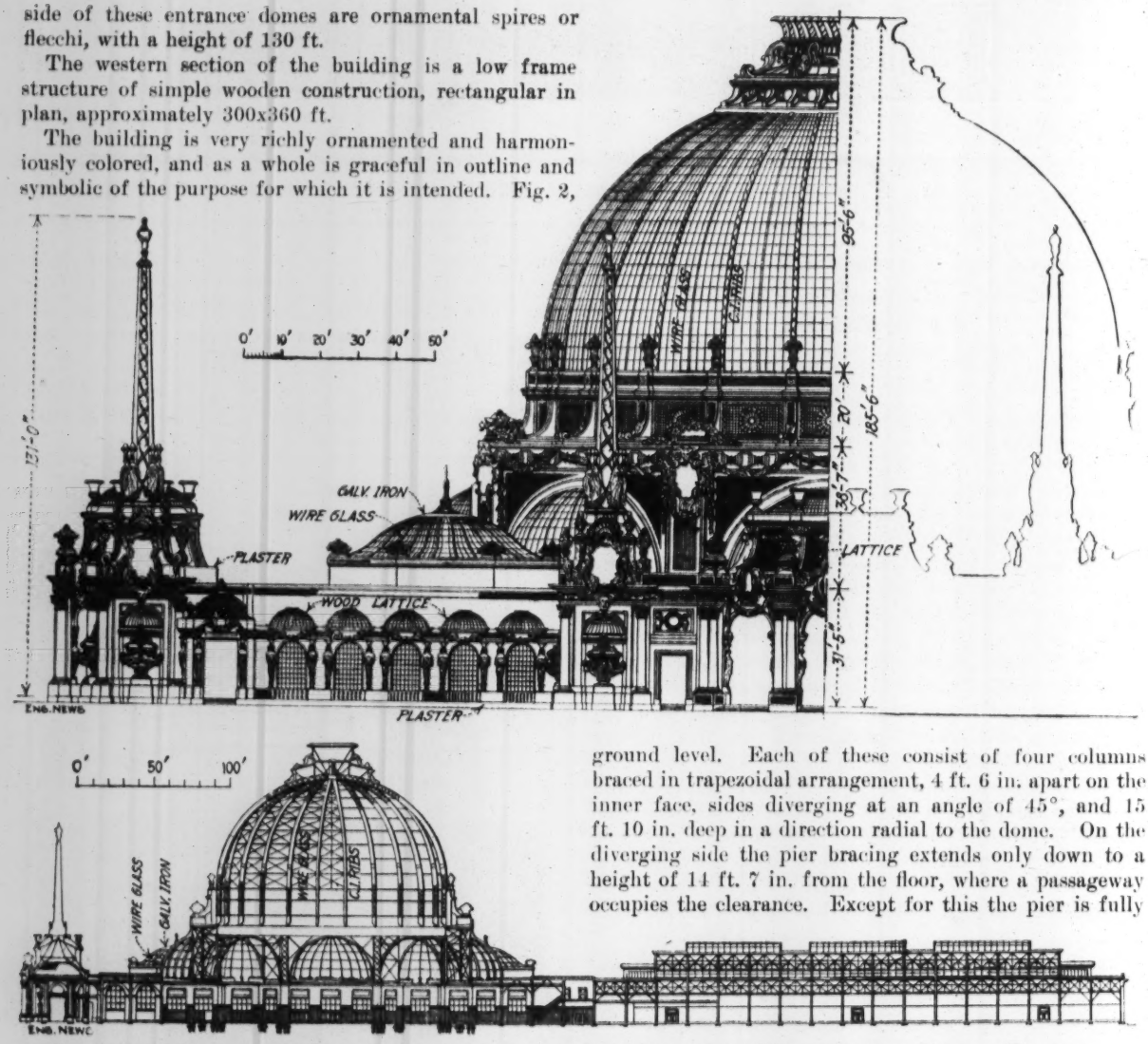
The Palace of Horticulture of the Panama-Pacific International Exposition at San Francisco

(The great glass-covered dome, 152 ft. in diameter, has a steel frame, but the rest of the building is largely wood-framed.)

side of these entrance domes are ornamental spires or flecchi, with a height of 130 ft.

The western section of the building is a low frame structure of simple wooden construction, rectangular in plan, approximately 300x360 ft.

The building is very richly ornamented and harmoniously colored, and as a whole is graceful in outline and symbolic of the purpose for which it is intended. Fig. 2,



SKETCH ELEVATION AND LONGITUDINAL SECTION OF THE PALACE OF HORTICULTURE, PANAMA-PACIFIC EXPOSITION

an elevation and cross-section of the building, will give a general idea of the entire construction in conjunction with the photographic view reproduced on the preceding page.

The dome is a ribbed framework of 24 latticed ribs 36 in. deep, connected at the top to a curb ring 6 ft. in diameter. The ribs continue down below the spherical part as straight vertical members a distance of 25 ft. The dome action, however, is terminated at the springing line of the dome by a 36-in. horizontal tie-ring. At the foot of the vertical portion of the rib no thrust is taken; the ribs rest simply on girders.

The arch ribs are connected by 11 horizontal lattice-girder rings. These act both as brace rings and as main purlins, carrying secondary ribs or rafters of 4-in. I-beams, on which rest wooden purlins supporting the skylight bars. Adjustable diagonal rods brace all panels between ribs and rings.

The total weight of steel in the dome, above the plate-girder supports of the ribs is 200 tons.

The dome is carried by eight piers 65 ft. high above ground level. Each of these consist of four columns braced in trapezoidal arrangement, 4 ft. 6 in. apart on the inner face, sides diverging at an angle of 45°, and 15 ft. 10 in. deep in a direction radial to the dome. On the diverging side the pier bracing extends only down to a height of 14 ft. 7 in. from the floor, where a passageway occupies the clearance. Except for this the pier is fully braced. Girders spanning between the piers in a double line on inner and outer faces of the piers provide the immediate support for the ribs of the dome and all adjacent roof framing.

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The Coke-Oven Gas Plant for City Gas, operated by the Citizens Gas Co., of Indianapolis, Ind., consists of its own plant of 100 byproduct coke ovens of 7¾ tons capacity and a leased plant having 41 byproduct coke ovens of 14½ tons capacity. The total carbonizing capacity is 900 and 600 tons per day, respectively. The old water-gas and coal-gas plants of the Indianapolis Gas Co. (now controlled by the Citizens Gas Co.) were operated for a time, but since March, 1914, only coke-oven gas has been produced. During the first half of 1914, the total coal carbonized was 204,045 tons, with a production of 160,300 tons of coke, all of which has been sold, while the output for the remainder of the year has been sold also. The sale of the byproducts has been satisfactory. The production of gas (exclusive of that used for oven heating) was as follows: Coke-oven gas, 956,258,000 cu.ft.; water-gas, 212,002,000 cu.ft., and coal gas, 17,670,000 cu.ft. Of the total 1,185,930,000 cu.ft., about 35,540,000 cu.ft. were used under boilers, and 1,056,385,000 cu.ft. were sold to consumers. The average heat value was 640.7 B.t.u. for the gas from the larger plant and 601 B.t.u. for that from the smaller plant.

Gravel-Road Construction in Wisconsin

Wisconsin is one of the states in which gravel is plentiful and has been used extensively for road construction, and under the present system of state aid and supervision in highway work a considerable amount of work is being done in the construction and improvement of gravel roads. For information as to this work we are indebted to A. R. Hirst, State Highway Engineer (at Madison), and W. M. de Berard, District Engineer (at Milwaukee).

The old practice in building such roads was to dump loose gravel, to be consolidated and worn down by traffic. The road was then neglected entirely until certain parts were practically destroyed, when holes and low spots would be filled with loose gravel deposited in the same way and usually in excessive quantities. Traffic would keep to the sides of these mounds of gravel, gradually forming a new roadbed and making eventually a very irregular line of road. One of the lines of work of the Wisconsin Highway Commission is to secure the proper use of this excellent material, and the proper maintenance of the roads built with it. The old road makes an excellent foundation for the new surface.

It is not always easy to secure the necessary coöperation of the local authorities or to make them realize that they are spending much more in this ineffective repair work than would be required for the proper reconstruction of the roads.

There has been a little difficulty also in initiating the construction and improvement of gravel roads by the Highway Commission, due to a general feeling in the rural districts that they needed no instruction in making roads of gravel. There was an impression also, that as Wisconsin has an abundance of limestone quarries the state authorities would substitute stone for gravel and thus greatly increase the cost, to the benefit of the stone companies. However, these latent suspicions are disappearing, as it is now being realized that it is the endeavor of the Commission to use local material where possible, and to combine strict economy and good work in all its road work.

Use of Varying Qualities of Gravel

While gravel exists in large quantities and over a large area of the state, it is of very varying character, requiring different methods of treatment to adapt it for making good roads. Practically no two gravels are alike, even though obtained from neighboring pits. For this reason it is required that deposits proposed to be used by local authorities on state-aid roads must be examined and approved by the engineers of the Commission.

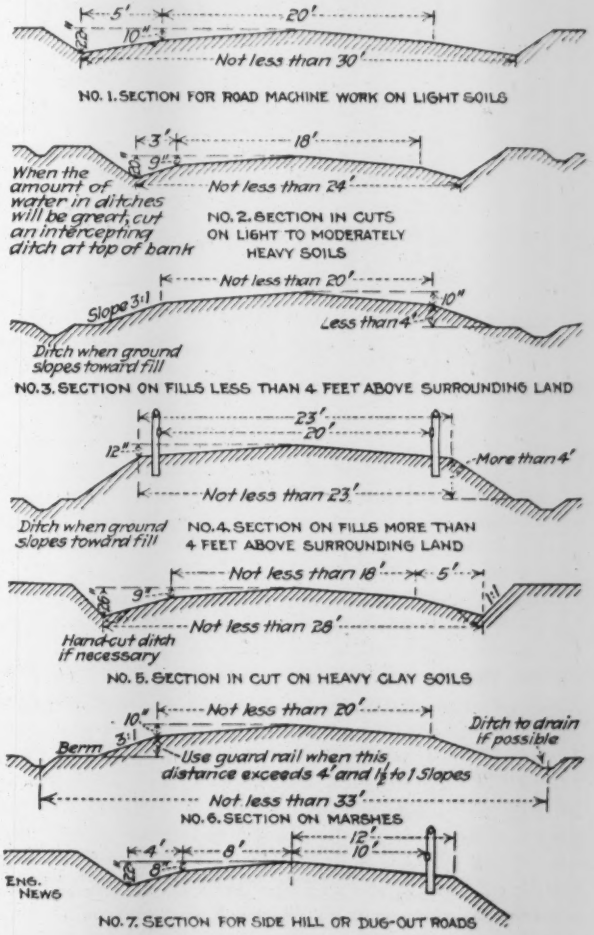
In certain cases the material is of such size and of such cementing character that the pit-run gravel can be put directly into the road. As a rule, however, it contains stones too large for use in the surface course, so that crushing and screening are necessary. Many deposits have too large a proportion of sand, while the sand is of a non-cementing character. In such cases the addition of clay as a binder may easily make the material suitable for use. In some locations washed gravel (prepared for concrete use) is available, and may be rendered satisfactory by the addition of clay and limestone screenings.

The gravel stones are usually very hard, and a gravel road is, therefore, more durable than one built with limestone or shaly stone, although local authorities may be inclined to prefer the latter on the general assumption that a "stone road" is a "hard road." Another favorable property of the gravel road is that it tends to wear evenly, and is much less liable to develop the holes and low spots which give a very rough riding surface to a partly worn road of soft stone. At the same time the gravel road is much less dusty. It is also less costly, even from the point of maintenance, as ordinary traffic suffices to compact loose gravel used to repair ruts and holes, if care is taken to select gravel having a percentage of clay or being of a cementing quality.

The width of road surface is 18 to 20 ft., with a 9-ft. graveled surface and 5 ft. shoulder on each side. On main roads with heavy traffic the graveled width is 18 ft. The form of roadbed used under different conditions is shown in the accompanying cut; these sections apply to finished gravel and macadam roads with 9-ft. surface, and also to earth roads. It will be noticed that with fills of over 4 ft. in height a post-and-rail fence is used for the protection of traffic. In some cases deviations or cutoffs are made to eliminate steep grades. Land may be condemned for these purposes, and the abandoned roadbed then reverts to the owner of the adjacent land.

Road Construction with Crushed Gravel

A majority of the gravel road work is done with


5'
20'
10"
Not less than 30'
NO. 1. SECTION FOR ROAD MACHINE WORK ON LIGHT SOILS
3'
18'
9"
When the amount of water in ditches will be great, cut an intercepting ditch at top of bank
Not less than 24'
NO. 2. SECTION IN CUTS ON LIGHT TO MODERATELY HEAVY SOILS
Not less than 20'
10"
Slope 3:1
Less than 4'
Ditch when ground slopes toward fill
NO. 3. SECTION ON FILLS LESS THAN 4 FEET ABOVE SURROUNDING LAND
23'
20'
12"
More than 4'
Not less than 23'
Ditch when ground slopes toward fill
NO. 4. SECTION ON FILLS MORE THAN 4 FEET ABOVE SURROUNDING LAND
Not less than 18'
5'
3'
Not less than 28'
Hand-cut ditch if necessary
NO. 5. SECTION IN CUT ON HEAVY CLAY SOILS
10"
Not less than 20'
Ditch to drain if possible
Berm
3:1
Use guard rail when this distance exceeds 4' and 1½ to 1 Slopes
Not less than 33'
NO. 6. SECTION ON MARSHES
4'
8'
12'
10'
8"
ENG. NEWS
NO. 7. SECTION FOR SIDE HILL OR DUG-OUT ROADS

Standard Cross-Sections for Gravel, Macadam and Earth Roads in Wisconsin (with Gravel or Macadam Surface 9 Ft. Wide)

crushed gravel. The crushing and screening are done at the pit, which is selected as near as possible to the work, and a portable plant is used, since the jobs are usually short (½ mile to 2 miles). One plant, which in many respects is typical, may be described as follows:

The gravel formed a small hill, with practically no stripping beyond the removal of sod, and was excavated by two or three wheeled scrapers working over a circular surface on the slope. At the lower side of the path the gravel was deposited beside a platform, beneath which was the portable crusher, of jaw type, adjusted for a product of ½ to 3½-in. size. A team at the lower level, on which the crusher stood, moved to and fro, pulling a slip scraper crosswise of the pile of material dumped from the wheel scrapers, and delivering it to the hopper of the crusher. A length of cable led from the team to the scraper.

An elevating conveyor raised the product to a three-size revolving screen, grading the material into screenings, ½- to 2-in. stone, and 2- to 3½-in. stone. In order to have a proper proportion of fine material, a part of the "screenings" section of the screen was wrapped with felt or sheet iron, so that both fine and coarse material would travel along to the coarse end of the screen. The crusher, elevator and screen were driven from a 20-hp. traction engine. The screen was over a three-compartment storage bin, with side chutes for loading the wagons.

From two to four drop-bottom dump wagons were used to convey the material to the road, according to the length of haul. The coarse material for the lower layer was dumped on a carefully prepared subgrade and was spread with rakes to a thickness of from 5 to 6 in. (seldom less than 4 in.), depending on the character of base soil or subgrade. Screenings or clay was then applied to prevent creeping under the roller and to secure good compacting, as the hauling of the second course takes place over the same, and with much better ease. This latter course was placed in the same way, to a depth of from 4 to 5 in. (seldom less than 3 in.), rolled dry; meanwhile screenings were spread until all the stone was covered. Then it was sprinkled and rolled thoroughly, giving the road a finished thickness of from 6 to 8 in., dependent on the depth of material placed.

An average force for such a job as described above would be about as given in the accompanying list: One foreman, one engineman, one helper, two or three men with wheeled-scraper teams (or wheelbarrows), two men with slip-scraper team, two men with slip scraper (or two or three shovelers), two to four men with dump wagons, one man spreading screenings, one roller driver, one tank-wagon driver, one water boy.

In another case, no scrapers were used, but three men at the pit shoveled the gravel into wheelbarrows which an equal number of men wheeled to the crusher on plank runways. These forces work six 10-hour days per week.

Such a force as listed above will build about 1500 to 1800 ft. of road per week, depending upon the amount of grading and ditching work to be done. The cost of the gravel at the pit is usually about 5 to 10c. per cu.yd. The cost of gravel roads built in this way averages 35 to 55c. per sq.yd., which includes the grading of roadbed but not the culverts (all of which are of concrete).

In some localities good binding gravels are scarce, but sandy gravels are available. These latter may be adapted to the purpose by the application of clay binder, suitable clay being generally found near the site. The best clay is that which breaks up into almost granular form, so that it mixes thoroughly with the gravel. The lower course is deposited, the clay spread and worked in as evenly as possible, and rolled. A manure spreader has been used to advantage in cutting and spreading the clay, and a farm drag or pulverizer in working it upon the road surface. The top course is then applied, rolled dry and covered with screenings; then thoroughly wetted and rolled until the clay is brought to the surface, after which it is left to dry out. At times a light application of sand or limestone screenings is applied to prevent the surface from picking up in case of rerolling and future travel.

It is considered advisable to oil the gravel roads when funds permit, and to do this the first year on roads subject to heavy traffic or those built early in the season, instead of allowing the road to wear for a year before this treatment.

Machinery

Each county has its own equipment, purchased usually by a committee of the county board, and generally in accordance with the advice or suggestion of the district engineer. The outfit includes road plows and graders, wheel and slip scrapers, water-sprinkling wagons, steam or gasoline rollers (10-ton usually), crushing and screening plant, and sometimes an oil-sprinkling wagon. In some cases farm dump wagons with slat bottoms are used, but where the money can be afforded the drop-bottom wagons are preferred. There is a tendency to use small water wagons with the result that there is often difficulty in keeping the work well sprinkled at the proper time. A 400-gal. tank is very generally used, but a 600-gal. tank is considered preferable and could be handled as easily on the work.

Organization

A brief description of the organization of the Wisconsin State aid road work was given in Engineering News, June 25, p. 1419. The State Highway Commission has nothing to do with roads, outside of this system. A township desiring the improvement of a road within its boundaries, with State aid, must vote an appropriation (not less than $400); the country and state them appropriate equal amounts, making a minimum of $1200 for the work in the township. The state-aid system of roads throughout the state is divided into seven districts, each of which is in charge of a district engineer of the Commission. These men spend most of their time visiting the various jobs, keeping in close touch with the county highway commissioners and with the foremen in direct charge of the work.

This system of oganization, whereby the local authorities initiate a piece of work and the local county highway commissioner takes the responsibility for its successful completion under the general supervision and advice of the State Highway Engineer and his assistants, has the advantage of establishing close and friendly relations between the local authorities and the State Highway Commission, avoiding jealousy or antagonism which may arise when the local authorities or the men on the work get the idea that the Commission is simply a set of officials issuing orders from an office in the capitol.

An exact and reliable record of cost is essential, so that the local authorities may be informed as to the disposal

of their money. The foreman makes daily report on a printed blank as to his force and work, and makes also a weekly report which shows his payroll. In this way he sees how his money is holding out in relation to the work to be done. These reports are given to the road commissioner, and at the end of the season a summarized cost report is made to the district (state) engineer, who measures up the work and (if it has been done according to the prescribed plans and methods) accepts the road for the state, with recommendation as to whether it should be turned over to the county for maintenance.

This being done, the county is required (under the law) to provide a continuing fund for the inspection and maintenance of the road. This maintenance then comes under the supervision of the district engineer, so that the new road will not be subject to injury by neglect or by the dumping of wagon loads of loose material for "repairs."

The system has worked very well in the short time it has been in operation, and the rural public generally has recognized its value. Thus there is a decline from the old sentiment that while the state should provide money the local authorities should have the spending of it, free from any state supervision.

Most of the road work is done by day labor, as the individual jobs are too small to pay a contractor to put his plant on them, and he could not be sure of getting a sufficient number of jobs to make the work worth while. The concrete road work, however, is done mainly by contract, although in Milwaukee County the county board has its own equipment and builds a large amount of concrete roads.

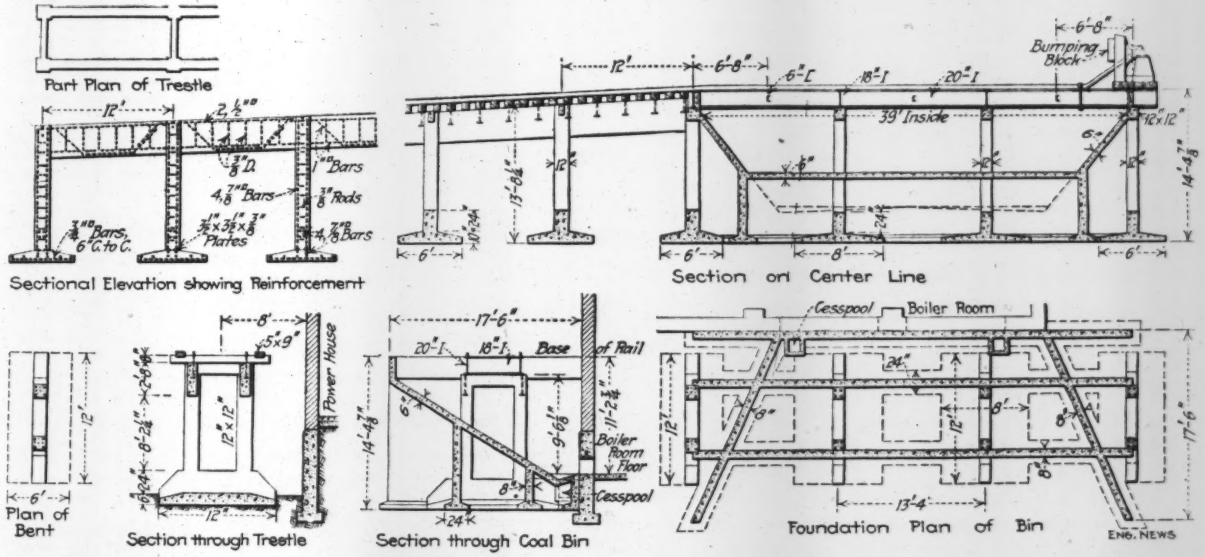
Concrete Trestle and Coal Bin

A coal bin and inclined trestle approach of reinforced concrete is an interesting feature of the new tie-treating plant of the Louisville & Nashville R.R. at Guthrie, Ky. The construction is shown in the accompanying cut.

The bin is alongside the boiler house, and is of hopper shape, with the ends and one side inclined. The other side is open to the boiler house, and the bottom slopes to the level of the floor so that coal is handled directly to the boilers. Its sides and ends are supported by a framing of longitudinal and transverse concrete walls, having broad footings on the red clay soil. The ends and two intermediate concrete bents support a pair of track stringers of 20-in. I-beams, between which are framed 18-in. I-beams and 6-in. channels. Upon the stringers are bolted the track rails. This open construction provides for free flow of the coal from hopper cars. The bin has a capacity of about 100 tons.

The approach trestle is on a grade of 4%. It is composed of a pair of 10x32-in. girders in 12-ft. spans between concrete bents. Each bent has a broad footing 12x6 ft., with two 12x12-in. posts, the posts being connected by a cross wall at the bottom and a strut at the top. All of this is a monolithic concrete structure, as shown at the left of the cut. Anchor bolts embedded in the girders for securing alternate ties provide against movement of the track on the incline. The ties are 8x8 in., 9 ft. long, laid directly upon the girders, and carry outside guard timbers 5x9 in.

The work was done under the direction of W. H. Courtenay, Chief Engineer, and J. B. Lindsey, Superintendent of Timber Treating Plants.



REINFORCED-CONCRETE COAL BIN AND TRESTLE AT GUTHRIE, KY.; LOUISVILLE & NASHVILLE R.R.

A New Medal to be awarded to those workers in physical science or technology, whose efforts have done most to advance the knowledge of physical science or its applications, has been established by the Franklin Institute through the gift of $6000 by Samuel Insull, of Chicago. The medal is to be known as "The Franklin Medal" and is to be made of gold of an intrinsic value of about $75. In case the income from the endowment creating the medal should be more than sufficient for the purchase of the medals, the medal may be accompanied by a premium to the recipient.

The Natural-Gas Gasoline Industry in this country has become of importance in the last three years. The production in 1913 amounted to 24,060,817 gal. valued at $2,458,443, an average price of 10.22c. per gal. as compared with a production of 12,081,179 gal. valued at $1,157,476, in 1912, and 7,425,839 gallons, valued at $531,704, in 1911. In 1913, West Virginia produced 7,662,493 gal., Oklahoma, 6,462,968; Pennsylvania, 3,680,096; California, 3,460,747; Ohio, 2,072,687; the balance was produced by Illinois, Colorado, New York, Kentucky, and Kansas.

Protecting Steelwork Against Locomotive Blasts

One of the greatest problems in the design of steel grade-crossing bridges is the protection of the floor systems and lower chords against the sand blast action of the locomotive exhaust and the corrosive effect of the locomotive gases. The requirements of grade are practically always such that the clearance above the locomotive stack is very small (in some well known instances less than 12 in.), so that the locomotive blast plays directly on the lower part of the bridge, and if it be not thoroughly protected, causes its very early destruction. In the cities of Buffalo and Cleveland, a great amount

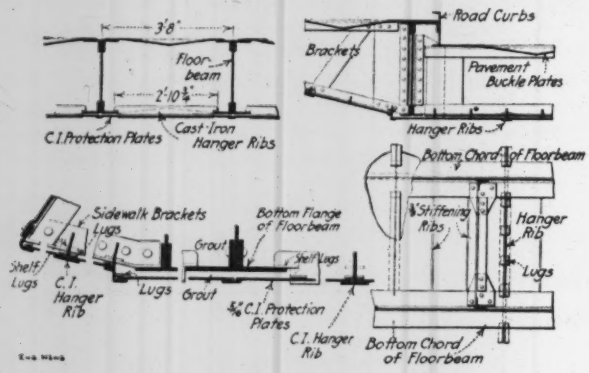


FIG. 1. METHOD OF PROTECTING THE UNDER SIDE OF STEEL BRIDGES AGAINST LOCOMOTIVE BLASTS

(Proposed by Robert J. Reidpath & Son for the Chicago St. Viaduct, Buffalo, N. Y.)

of grade-crossing work has been done, and a number of different methods of protecting the lower parts of the steel over bridges have been tried.

In 1913, Robert J. Reidpath & Son, consulting engineers, made a report to the city of Buffalo on the condition of a number of the steel overhead grade-crossing bridges in that city. They found that a great number had been seriously affected by the locomotive blasts and described their condition in the following paragraphs, which indicate the extent of such action:

In the year of 1907, the steelwork in the Michigan St. bridge was cleaned by means of a sand blast and well painted with red lead. The floor system and lower chords were given a coat of portland cement wash over the red lead, which had the effect of stopping corrosion and the action of the locomotives' gases eating into them to some extent but not sufficiently to prevent it altogether, and not at all where the locomotives exhaust and smoke is brought in direct contact with the steel. To the best of our observation, the steelwork in the bridge, above the lower chords and floor system, is in a fairly good condition, except for the want of a good cleaning and paint.

Some of the flange angles in the lower chords of span No. 3, that were originally ¾-in. thick, have been eaten away until the remaining metal is only ½-in. thick. These members are among the most important parts of the bridge and subjected to the greatest strains.

The flange angles in the plate girder floor-beams, spanning between the trusses and carrying the roadway, were originally $^{20}/_{32}$-in. thick; they have eaten away until only $^{9}/_{32}$-in. remain; in other words, over one-half of the steel is gone. These angles take the tensile strength of the girders and carry the entire loads. The web plates in these girders were originally ⅜-in. thick; they are now $^{7}/_{16}$-in. thick.

The bridges in Louisiana St. are in a fairly good condition, with the exception that some of the floor-beams are considerably reduced in strength due to the same causes that have impaired the steel in the other bridges. This occurs in only a few places particularly over the tracks where the locomotives are operated most frequently in switching, etc.

The trusses and floor-beams are eaten away in places where the concrete protection has been forced off by the action of the blast from the locomotives exhausting and by frost. Chunks of this concrete, carrying in weight up to twenty-five pounds, are dropping down daily and endangering the lives of the yardmen working below.

In the Seneca St. bridges, over the Pennsylvania, New York Central and Lake Shore tracks and the Hamburg St. bridge over the same, the steelwork above the lower chords and the floor system is in fairly good condition although there is quite an accumulation of rust that should be removed and the steel painted.

The floor systems are in a very bad condition. The most important members, those supporting the ends of the floor-beams and their loads, will not last but a little while longer and are liable to fail at any time under an unusual load suddenly applied. Originally the steel in the flanges in these girders was $^{7}/_{16}$-in. thick, in some places nothing is left; in other places where it is not entirely gone it varies in thickness from $^{5}/_{16}$-in. up to an original thickness according to location. The webs of these girders were ⅜-in. thick, they are now only ⅛-in. thick.

Many of the steel cantilever brackets that support the sidewalks are eaten away to such an extent that in places there is no steel left and what remains is only ⅛-in. thick.

The flange angles of the floor-beams when built were ⅝-in. thick, many of them have been eaten away until there is only ¼-in. of metal left and in some places only ⅛-in.

The short plate girders between the floor-beams over which the tracks of the street car company, are laid, in many instances, almost eaten away. The web plates were originally $^{5}/_{16}$-in. thick; they are now less than ⅛-in. thick. In some places one entire leg (one-half) of the flange angles are gone.

The floor-beams and bottom chords of these structures were cleaned and painted in 1911-12; previous to that they suffered severely from corrosion and the effects of gas and smoke from the locomotives. Where they are subjected to the direct action of the exhaust from the locomotives, the paint is all off and they are again badly rusted.

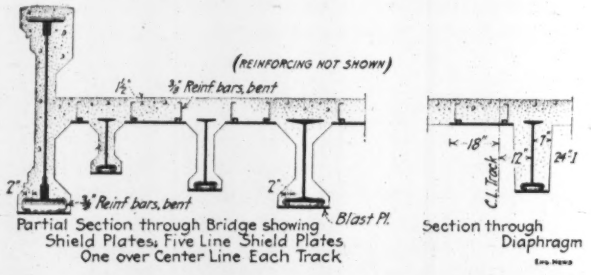


FIG. 2. CAST-IRON PLATE PROTECTION, QUINCY AVE. GRADE CROSSING, CLEVELAND, OHIO

The bridges in Seneca St. over the Buffalo Creek, Erie and Nickel Plate tracks and the bridge in Smith St. over the Erie tracks, etc., are also in bad condition. The viaducts according to the limited amount of information we have at hand are not strong enough to stand the traffic of the heavier type of steel cars and should be strengthened before they are allowed upon them.

These bridges are badly corroded throughout their floor systems and lower chords. It has reduced their thickness and greatly impaired their strength. They are covered with a heavy coat of rust.

In some places in the lower chords where the web plates were originally ¾-in. thick they are now ⅛-in. The flange angles originally were $^{9}/_{16}$-in. thick, they are now only $^{5}/_{32}$-in., just one-half of their original size.

In the floor-beam the flange angles originally were ⅝-in. thick, they now vary from ⅜-in. to $^{5}/_{32}$-in.

The floor-beams and floor plates in these bridges and viaducts were cleaned and painted during the year 1909-10. Previous to that, the deterioration had been considerable, painting checked it to some extent but did not stop it where the steel was subjected to the direct action of the gases from the locomotives. It is now corroding and being rapidly eaten away. In a short time, the metal will be entirely gone in many vital places on the structures.

None of these bridges or viaducts are in such a condition that it will be necessary to take them down, the greater portion of them can be saved and made to do service for

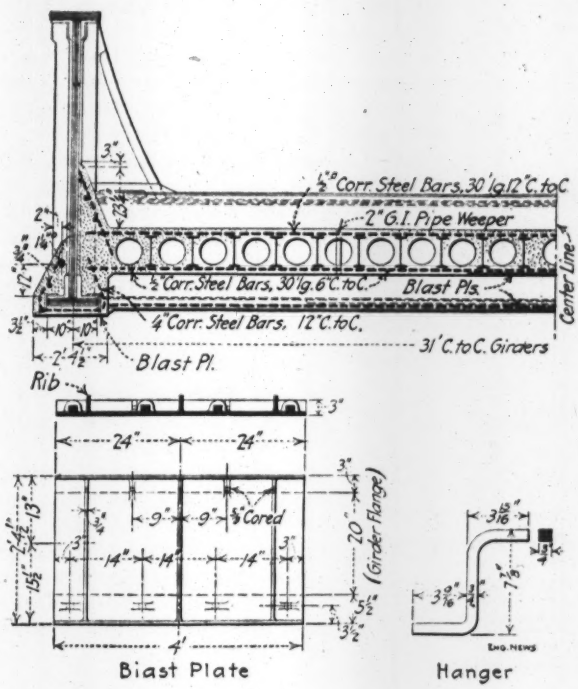


FIG. 3. CAST-IRON BLAST PLATE ON CLEVELAND SHORT LINE-NICKEL PLATE GRADE CROSSING, CLEVELAND, O.

many years, but the floor systems and parts of the lower chords and several of the piers and abutments must be rebuilt. In doing so, proper precautions should be taken to prevent the gases and smoke from the locomotives injuring them. The natural corrosion can be almost entirely prevented by properly and frequently painting them after they are once more cleaned.

This report indicates that there was a deplorable lack of inspection and maintenance in all of the structures mentioned, which accounts for the serious deterioration they suffered, but at the same time it is evident that the lower parts of the bridges, subjected to the locomotive blast, were affected more than the remainder of the structure.

To guard against this action, the several methods noted below have been tried:

CAST-IRON PLATES—It is generally conceded that cast-iron plates withstand the sand-blast action of the exhaust as well as, or better than, any other material, but they are needed only in the path of the locomotive stack. A durable coating, light in weight, which possesses qualities of protecting portions of the structure adjacent to the tracks and between them against injury from steam and gas must be found if the cost of separating grades by carrying the streets over the railroads on long viaducts is to be kept down to what the city and railroads can afford to pay. The method of encasing or embedding the steel-floor system in concrete with cast-iron plates to take the sand-blast action is positive, but it adds considerably to the cost.

A very good example of the cast-iron plate protection is shown in Fig. 1, which is the viaduct across the New York Central, West Shore, and Erie railroads at Chicago St., Buffalo, one of the first crossings to be eliminated. This was closed to all traffic a shore time ago because of its dangerous condition, and to permit extensive repairs, consisting of reinforcing or replacing members damaged principally by locomotive exhaust. Reconstruction plans include the placing of a ceiling of cast-iron plates over the tracks according to design by Robert J. Reidpath & Son. It will be noticed that the lugs and hanger ribs as well as the plates are of cast-iron. Inasmuch as it will be difficult to inspect the steel after the plates are up, penetration of the gases through the interstices between them will be prevented by plastering them on the back with cement mortar. One thought was to fill the interstices with lead and oil.

Fig. 2 shows the method of applying cast-iron plates to the base of the concrete incasement of the girders in the Quincy Ave. grade crossing of the Nickel Plate R.R. in Cleveland. Here the minimum clearance is 16 ft. 3

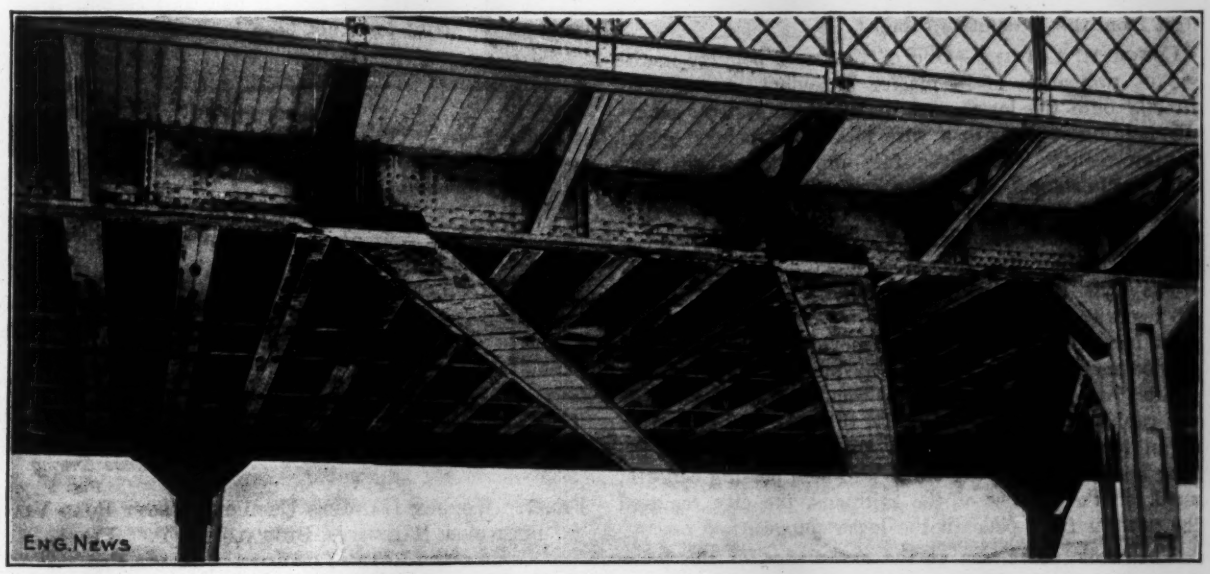


FIG. 4. UNDER FLOOR OF HAMBURG TURNPIKE VIADUCT, BUFFALO, N. Y., SHOWING CAST-IRON BLAST PLATES AND CEMENT GROUT OVER RED-LEAD OIL PAINT

in. To incase in concrete each floor-beam, which are about 3 ft. c. to c. on this bridge, required expensive forms and great care in placing concrete. The mix was quite wet in order that it would run from above and completely fill the form around the lower flange. Silica gravel, such as is used to finish parkways, was used instead of crushed stone for the matrix.

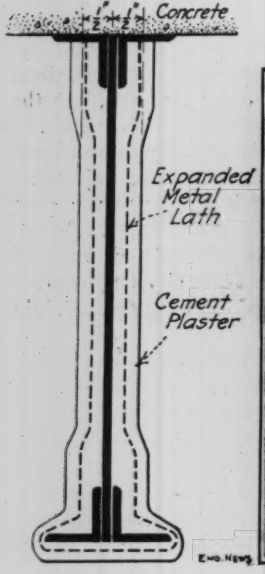


Fig. 5

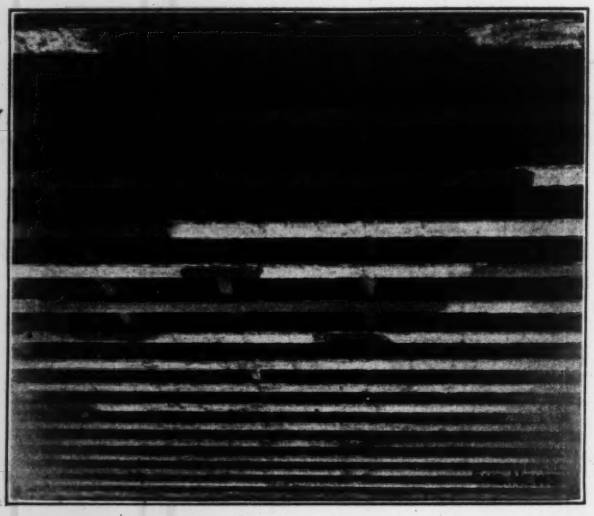


Fig. 6

FIGS. 5-6. ELK ST. VIADUCT OVER RAILWAYS, BUFFALO, N. Y.

Fig. 5. Detail of floor-beam showing concrete protection. Fig. 6. Underside of floor after concrete was removed. Cement mortar fell from dark spots. Light areas where concrete was taken off for safety.

Fig. 3 gives the detail of the cast-iron protection plates on the Nickel Plate-Cleveland Short Line crossing at Cleveland.

Another instance of this cast-iron localized protection plate is shown in Fig. 4, which is the Hamburg Turnpike viaduct over the Buffalo Creek R.R., at Buffalo. Here, cast-iron plates carried by cast-iron hanger ribs resting on the lower flanges of the floor-beams take the blast from the locomotive exhaust.

CONCRETE COATING—One of the most popular methods of protection is to plaster a cement mortar coat directly onto the lower part of the floor system, generally holding it on with a wire mesh or expanded metal reinforcement. This gives fair protection under certain circumstances, when the concrete is thick enough or the reinforcement far enough from the surface, but there have been some places where it has failed. Figs. 5-6, which show the Elk St. viaduct over a number of railways at Buffalo, illustrates one such case. About six years ago, floor-beams and stringers of this structure were incased in ½-in. cement mortar plastered on expanded metal lath. It served its purpose very well for a time except over the center line of tracks, where it was rapidly cut away. Recently, this concrete protection began to fall in chunks from the lower flanges of the floor beams, endangering trains and men passing beneath, until, at the request of the railroads, the city removed the portion from beneath the lower flanges.

The weak point was at the outer edge of the lower flange of the floor-beams, with which the metal lath was left in contact during construction. No plaster got between the lath and the edges of the angles, with the result that rusting set up and destroyed the lath. Vibration, due to trains passing beneath and traffic overhead, broke the plaster at these lines of contact. The gases appeared to have no effect on the plaster other than to darken it about ⅛ in. deep. If the reinforcement were a little sturdier, and care were exercised to have it incased in the mortar, this method of protection, in combination with cast-iron plates over the center of the tracks, would give satisfaction.

PAINT AND CEMENT COATING—As noted above, that part of the floor not directly subjected to the sand blast usually requires some minor protection. A novel method of thus coating steel, applicable both to new structures and to old ones where no protection has been attempted other than painting, has been in use in Buffalo for a number of years. In principle, it combines in an inexpensive manner the properties of protection belonging to both paint and cement.

After the steel is erected, a coat of red lead and oil is applied, mixed in the proportions of 25 lb. of red lead to each gallon of linseed oil. While the paint is still wet, lake sand is thrown against it, so that the grains are embedded about half their diameter in the paint. After it is thoroughly dried, two coats of cement grout, creamy in consistency, and mixed in the proportions of one part of lake sand to one part of cement, are applied with brushes. The Hamburg Turnpike viaduct, shown in Fig. 4, has been treated in this fashion, outside of the cast-iron plates over the track centers.

Costs of applying the sand binder and cement grout coats to the paint have not been kept separately, as the

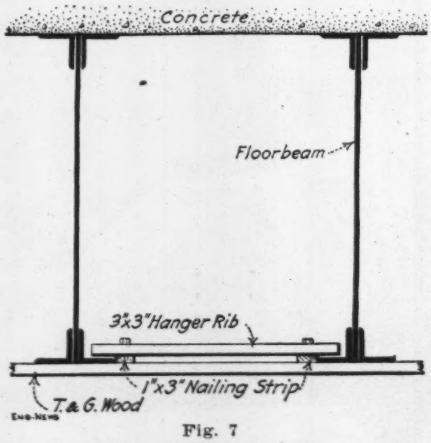


Fig. 7

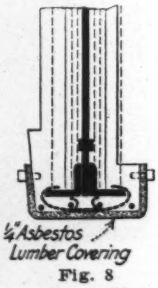


Fig. 8

FIG. 7. WOODEN HANGERS USED ON ABBOTT ROAD VIADUCT OVER RAILWAYS, BUFFALO, N. Y. FIG. 8. ASBESTOS BOARD LOCOMOTIVE BLAST PROTECTION, AMHERST, ST. GRADE CROSSING, BUFFALO, N. Y.

work was included in general specifications covering an entire job. Thus, at the Hamburg Turnpike, the contractor erecting the steel painted it and applied the cement grout. It is probable that the cement gun could be used to advantage to apply both the sand binder and the grout, guarding against getting the latter too thick.

On the Hamburg St. viaduct (distinct from Hamburg Turnpike), over the Erie, Pennsylvania, and New York Central railroads at Buffalo, the grout has been doing service for four years and is in good condition except over the tracks, no special provision being made to care for the sand-blast action. The method of combining paint and grout in a protective coating was originated by Capt. George H. Norton, deputy engineer commissioner.

Wood and Asbestos Boards—Another method of protection tried out was to ceil the underside of the viaduct with tongue and grooved boards nailed to 1x3-in. strips bolted to wood 3x3-in. hanger ribs resting on the lower floor-beam angles (Fig. 7). The boards shrunk in the dry summer months, admitting gases through the cracks. During the rest of the year they swelled so that the ceiling bulged and had to be taken down to keep it from falling on trains and men.

Still another method was to attach ¼-in. asbestos lumber by means of ¾-in. oak plugs to the under side of concrete encasing girders or floor beams. This method was first designed for the Amherst St. bridge over the New York Central R.R., at Buffalo, in 1908. A detail is shown in Fig. 8. This has been satisfactory except after several years the oak plugs become loose.

scratch coat over the concrete. This surface is relieved by a smooth brush finish for the concrete of the coping, string course, the panel moldings on the end pedestals, and the moldings of the open panels in the parapet wall. The contrast of the rough gray stucco with the smooth and lighter-colored concrete is very effective.

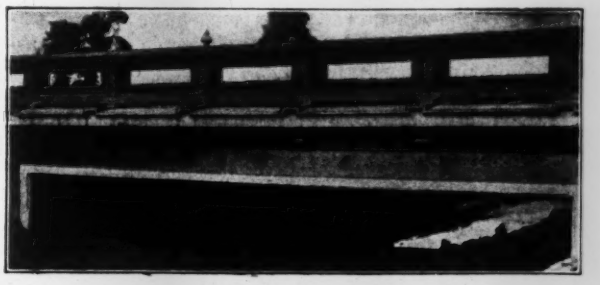


Fig. 2. Exterior Finish of the Park Bridge

(The darker part of the surface is a rough stucco; the coping, paneling, etc., are of smooth brush-finished concrete.)

The architectural details for the bridge were prepared by Geo. E. Kessler & Co., landscape architects, and the structural details by W. S. Will, of the Park Department of St. Louis. The bridge was built by the park forces under Nelson Cunliff, Superintendent of Construction, at a total cost of $4300.

The policy of the department is to do all its varied work by its own force rather than by contract. The force numbers some 125 men, engaged on concrete work of various kinds, paving and the multifarious items of work required in park improvement and maintenance. This force is under the direction of Mr. Cunliff. Dwight Davis is Park Commissioner.

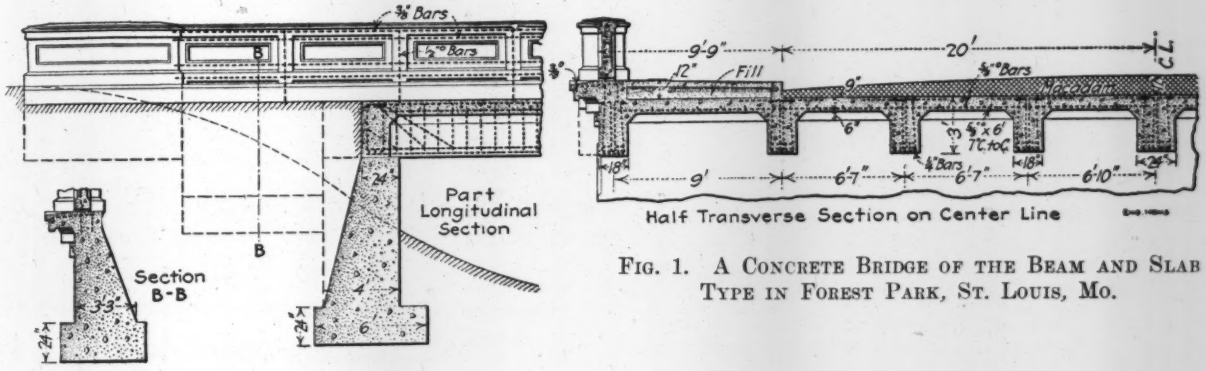


Fig. 1. A Concrete Bridge of the Beam and Slab Type in Forest Park, St. Louis, Mo.

A Park Bridge of Reinforced Concrete

Among the various engineering works for the improvement of Forest Park, at St. Louis, is a reinforced-concrete bridge carrying a main driveway over a storm-water channel. The clear span is 30 ft. and the length over parapet walls is 60 ft. The bridge has a 40-ft. roadway and two 9-ft. sidewalks. It is designed to carry a 10-ton steam roller and a load of 100 lb. per sq.ft. The bridge is of the beam and slab type, with nine beams 3 ft. deep (including the 9-in. slab). The concrete is a 1:3:4 mixture, made with broken stone, and the reinforcement is of deformed bars. The abutments and the side walls of the approaches are of gravity section.

A rough stucco finish was applied to the exterior, the forms being removed 14 days after the concrete was poured and the stucco coat (1:2) then plastered on a

Interior Fire Walls for safeguarding lives in hospitals and other public institutions, according to the plan developed by H. F. J. Porter, of New York City, have been adopted by the Department of Charities, New York City, and are to be installed in a number of the principal buildings. The department had requested from the Board of Estimate an appropriation of $200,000 to install on certain hospital buildings fire escapes and cylindrical chutes down which patients were to be slid in case of fire. Before action was taken by the Board of Estimate on this request, President McAneny had his attention called to the horizontal division fire-wall system described by Mr. Porter at the Baltimore meeting of the Society of Mechanical Engineers and in "Engineering News" of July 31, 1913. Expert investigation was made, and it was decided to install this system in place of fire escapes. The Department of Correction has also asked appropriations to construct similar walls in its institutions, which contain large numbers of inmates whose lives would be in peril in case of fire.

Flood Prevention Reservoirs in Bohemia

By Kenneth C. Grant*

Two notable reservoirs for flood control are now nearing completion on the Elbe River, near its headwaters, in northern Bohemia. They are being built by the Commission for River Regulation in Bohemia. The Austrian government will pay 60% of their cost and the Bohemian government 40%.

Königreich-Walde Reservoir

This project was begun in 1910, and in 1912 had reached the stage shown in Fig. 3, which was taken by

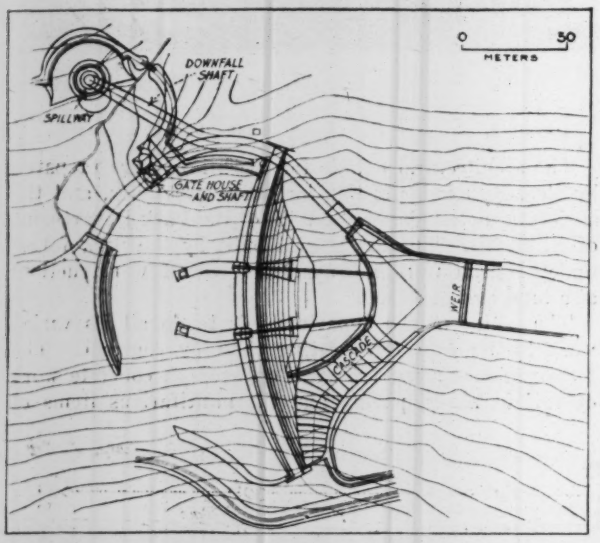


Fig. 1. General Plan of the Königreich-Walde Flood-Prevention Dam, Bohemia

the writer in July, 1912. The dam is located on the Elbe River, just above Königinhof.

The annual rainfall over the entire drainage area above the dam averages 35.4 in., and varies between 23.6 in. and 43.3 in. The maximum 24-hr. rainfall occurred on July 29, 1897, and at one station, Friedrichsthal near Spindelmühle, reached 7.3 in., or 20.6% of the mean annual over the catchment area. The total rainfall at this station for this storm, July 27-31, was 11.1 in., or 31.3% of the mean annual over the catchment area.

The maximum recorded discharge at the dam site, which occurred July 29, 1897, is 11,650 sec.-ft., or 58.2 sec.-ft. per sq.mi. The peak of the flood lasted for only 2 hr. The minimum discharge is 53 sec.-ft., or 0.265 sec.-ft. per square mile. The average low-water discharge is 141 sec.-ft., or 0.705 sec.-ft. per square mile.

The reservoir has a capacity of 320,887,000 cu.ft. and controls a drainage area of 200 sq.mi. 268,487,000 cu. ft., or 84 % of the capacity, will be kept empty for flood control. When full, the reservoir extends 4.65 miles upstream from the dam and covers an area of 222 acres to a maximum depth of 98.5 ft.

The dam contains 124,100 cu.yd. of broken-stone masonry, and is 136 ft. high, 23.6 ft. wide on top, 124 ft. wide on the base and 735 ft. long on the crest. It is arched upstream with a radius of 656 ft. The great width of the base (91% of the height) is due to the fact that the dam is designed to take care of full uplift pressure. This was felt to be wise in view of the important towns, Königinhof, Hohenelbe, etc., and the large industrial and other interests lying not far downstream. At the same time, every precaution has been taken to prevent any upward pressure due to the penetration of water into or under the dam. The upstream side has been provided with a watertight coating from the foundation up, and the interior of the dam has a complete drainage system. The maximum pressure at the toe of the dam, with full uplift pressure, is estimated to be about 12.8 tons per sq.ft. The borings and tests made of the sandstone upon which the dam is founded show that it will carry from 510 to 920 tons per sq.ft.

During construction, the river is being carried around the dam site in two tunnels, 19.7 ft. in diameter, bored through the solid rock of the hillsides. About 200 ft. above the main dam, and just below the upstream portals of the tunnels, is a low earthen diversion dam, 262 ft. long and 15 ft. high, with a masonry core wall. The tunnels empty into the river channel about 340 ft. below the main dam.

When the dam is completed, these tunnels will be closed by bulkheads, and through each bulkhead will pass three 43¼-in. pipes, provided with gates operated by spindles through a vertical shaft from a gate house above. With the reservoir full, these six pipes will discharge 3180 sec.-ft., which is the capacity of the channel below the dam. There are also two 43¼-in. pipes through the dam, provided with double gates, to supply water to the power house below the dam, where from 450 to 600 hp. will be developed by three turbines.

There are two circular spillways above the dam, one on each side of the valley, emptying into the tunnels below the bulkheads through downfall shafts. The crest of the spillway on the left bank is 853 ft. long, and is set at such an elevation that, with the reservoir full to a capacity of 320,887,000 cu.ft., the discharge will be 2470 sec.-ft. The spillway on the right bank (Fig. 4)

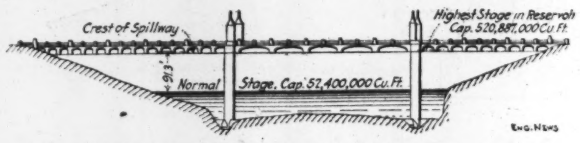


Fig. 2. Elevation of Königreich-Walde Dam

is 820 ft. long and discharges 3880 sec.-ft. with the reservoir full.

There is also a spillway 177 ft. long over the middle of the dam, consisting of five arched openings under the roadway across the dam, each 35.4 ft. long. The crest is 9.85 ft. below the crest of the dam proper, and 1.97 ft. below the level where the capacity is 320,887,000 cu.ft. The discharge over this spillway, with a depth of 1.97 ft., is 2120 sec.-ft. With a depth of 5.15 ft., which still leaves a freeboard of 4.7 ft., 11,650 sec.-ft. will discharge over this spillway. Thus if all the other outlets are out of order, the entire maximum discharge can be safely taken care of by this spillway.

Water passing over this spillway is received on a water cushion formed by a low masonry dam about 65 ft. below the foot of the main dam. A second water

*City National Bank Bldg., Dayton, Ohio.

cushion, to receive the flow from the tunnels, is formed by a low masonry weir directly below their downstream portals. The bed of the stream is carefully paved for about 440 ft. below the dam.

Discharge Control

The discharging apparatus of the dam will be manipulated during a flood as follows: During the first part of the flood, as the reservoir is filling, the six tunnel pipes will be kept discharging at full capacity. When the reservoir is full these pipes will discharge 3180 sec.-ft., which is the capacity of the channel below the dam. If the inflow should still exceed this amount, the water would begin to flow over the spillways above described, and the maximum discharge would be taken care of as follows:

Through the six tunnel pipes	3,180 sec.-ft.
Over the left circular spillway	2,470 sec.-ft.
Over the right circular spillway	3,880 sec.-ft.
Over the dam spillway	2,120 sec.-ft.
Total	11,650 sec.-ft.

If the tunnel pipes were out of commission, the total maximum discharge could pass over the three spillways with an increased depth of only 0.75 ft., leaving a freeboard of 7.13 ft. If the two downfall shafts were also out of commission, as noted above, the dam spillway could carry the maximum discharge and still leave a freeboard of 4.7 ft. All the provisions for discharging more than 3180 sec.-ft. are considered by the designers of the dam to provide a very large factor of safety, because records show that the peaks of the floods last but a short time and will always have passed before the reservoir is full.

The total cost of the reservoir, including land, damages, etc., will be $965,000, or $3000 per mill. cu.ft. of storage.

Krausebauden Reservoir

The construction of this project was begun in 1910 and is now practically completed. The dam is located near the headwaters of the Elbe River, a short distance below the town of Spindelmühle, and 21.4 mi. above the Königreich-Walde dam.

The annual rainfall over the entire drainage area above the dam averages 47.2 in., and varies between 35.4 in. and 55 in. The maximum 24-hr. rainfall and the maximum rainstorm are as noted above for Friedrichsthal, which is near the dam site.

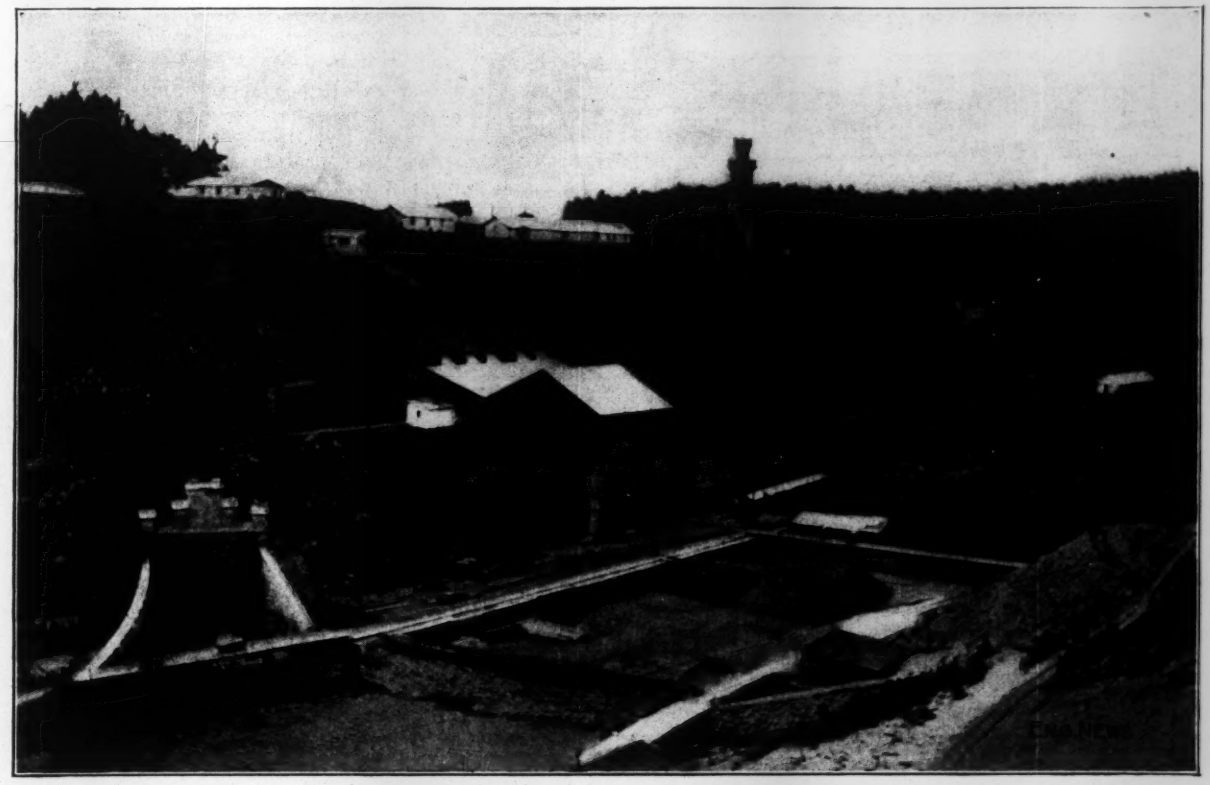


Fig. 3. Looking Upstream at the Site of the Königreich-Walde Dam during Construction

The maximum recorded discharge at the dam site, which occurred in July, 1897, is 7060 sec.-ft., or 315 sec.-ft. per sq.mi. The minimum discharge is 10.6 sec.-ft., or 0.472 sec.-ft. per sq.mi. The minimum low-water flow of long duration lasted for 100 days, and averaged 35.3 sec.-ft., or 1.58 sec.-ft. per square mile.

The reservoir controls a drainage area of 22.4 sq.mi. and has a capacity of 119,491,400 cu.ft., 105,900,000 cu. ft., or 88.5% of which will be kept empty for flood storage. When full, the reservoir is 1.12 miles long and covers an area of 71.7 acres to a maximum depth of 107 feet.

The dam contains 65,450 cu.yd. of broken-stone masonry and is 136 ft. high, 16.4 ft. wide on top and 118.2 ft. (87% of the height) wide on the base. It is arched upstream and has a crest length of 492 ft. The dam is designed for full uplift pressure. The greatest pressure

at the downstream toe of the dam with the reservoir full is 12.3 tons per sq.ft. With the reservoir empty, the pressure at the toe of the dam is 9.28 tons per sq.ft., and at the heel is 9.35 tons per sq.ft. The dam is founded on a hard gneiss, rich in quartz, which was reached at a

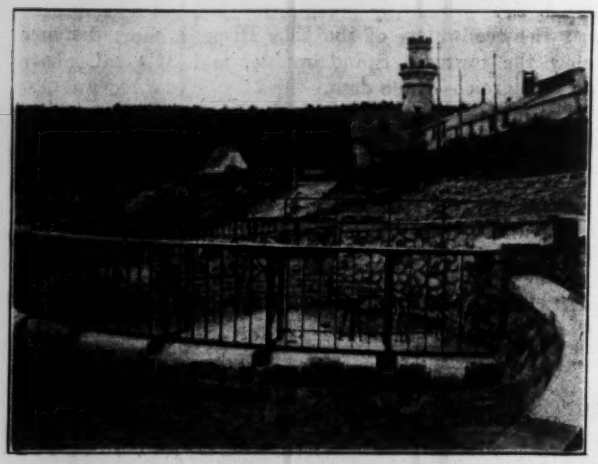


FIG. 4. KÖNIGREICH-WALDE DAM. SPILLWAY ABOVE DAM ON RIGHT SIDE OF VALLEY

depth of from 13 to 16 ft. in the bed of the stream and of about 3 to 4 ft. on the sides of the valley.

The foundation for the dam was prepared, after excavation, by filling all cracks in the rock surface with cement mortar. Twenty-three small springs which had been uncovered were enclosed in vitrified clay pipe, from 6 to 8 in. in diameter, so that they could be safely conducted out of the dam by the drainage system. The whole bed of the stream was then leveled up with concrete of a 1:2:4 mixture in a terraced form to give a uniform footing for the dam.

To prevent the entrance of water into the dam it is provided with a reinforced-concrete facing on the upstream side. The Hennibique system was used in the construction of this facing. In addition, the upstream face has been given two waterproof coatings. The interior of the dam is provided with a complete drainage system.

The river was carried around the dam site during construction in a tunnel 23 ft. in diameter and 475 ft. long, bored through the solid rock of the hillside around the left end of the dam. The flow was diverted into this tunnel by a concrete dam 39.4 ft. high, about 210 ft. upstream from the main dam. This diversion dam is arched upstream and is faced with masonry about 20 in. thick on the downstream side.

The diversion tunnel is now closed by a bulkhead through which pass five 43¼-in. pipes with gates operated by spindles through a vertical shaft from a gate house above. With the water 51.2 ft. below the spillway, at which level the flood-storage capacity of the reservoir is empty, these five pipes will discharge 2470 sec.-ft., which is the capacity of the channel below the dam. With the reservoir full these pipes will discharge 2900 sec.-ft.

On the left side of the valley above the dam there is a circular spillway 197 ft. long, with its crest 9.52 ft. below the crest of the dam. This spillway discharges through a downfall shaft 16.4 ft. in diameter into the tunnel below the bulkhead. With a depth of 1.92 ft. on the crest, the discharge over this spillway is 1235 sec.-ft. With a depth of 3.61 ft., the discharge is 3530 sec.-ft.

There is also a spillway 131.2 ft. long over the main dam at the right end, consisting of four arches, each 32.8 ft. wide in the clear. The crest of this spillway is at the same level as that of the circular spillway above the dam, i.e. 9.52 ft. below the crest of the dam. With a depth of 1.92 ft. on the crest, this spillway will discharge 1235 sec.-ft.; with a depth of 3.61 ft., 3530 sec.-ft.; and with a depth of 5.58 ft., 7060 sec.-ft. The discharge from this spillway is conducted between training walls over a paved cascade on the rocky side of the valley to the paved stream-bed below the dam, where it falls into a water cushion, later described.

There are also two 43¼-in. pipes through the dam, with gates above and below the dam. These furnish water to a small power house below the dam where 120 to 150 hp. will be developed. They are not reckoned as a part of the equipment for flood-control manipulation.

DISCHARGE CONTROL

The manipulation of the reservoir during a flood takes place in this manner. During the early part of the flood, the five tunnel pipes are kept discharging at the rate of 2470 sec.-ft., the capacity of the channel below the dam. As soon as the inflow exceeds this amount, and the flood-storage capacity begins to fill, the gates are gradually

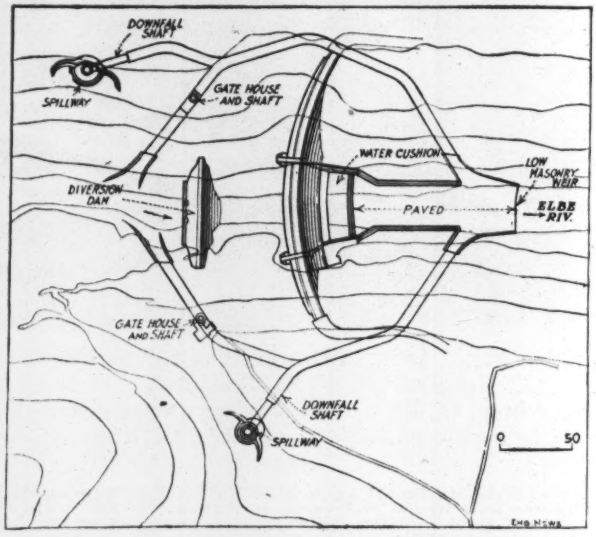


FIG. 5. GENERAL PLAN OF KRAUSEBAUDEN DAM, BOHEMIA

closed down with the increasing head, in such a manner as to keep the outflow constantly at 2470 sec.-ft. As soon as water begins to flow over the spillways, the gates are closed more rapidly, until, when the water is 1.92 ft. deep on the spillways, they are entirely closed, and 2470 sec.-ft. is passing over the spillways. If for any reason the gates should be out of order, or the discharge pipes blocked, the maximum recorded discharge, 7060 sec.-ft., can be accommodated by the two spillways with a depth of 3.61 ft. on their crests. Further, if the circular spillway or downfall shaft or tunnel should for

any reason be out of commission, the entire 7060 sec.-ft. could be taken care of over the main spillway alone, with a depth of 5.58 ft., and still leave a freeboard of 3.94 ft. below the crest of the dam proper.

About 250 ft. downstream from the toe of the dam, a concrete weir, 4.3 ft. high, has been built to provide a

FIG. 6. KRAUSEBAUDEN DAM IN COURSE OF CONSTRUCTION
(Looking Upstream, Showing Diversion Dam.)

water cushion to receive the discharge from the tunnel and the cascades leading from the dam spillway. The upstream training wall of the cascades is extended across the stream bed about 130 ft. above this weir, and joins the upstream side of the tunnel portal. With 2470 sec.-ft. discharging from the reservoir, a water cushion about 8 ft. deep is provided in the space between the training wall and the weir. This space and the streambed for about 25 ft. below the weir is carefully paved with masonry 3 ft. thick.

THE WORK OF THE RIVER-REGULATION COMMISSION

The Commission for River Regulation in Bohemia has been in existence since 1903. Since that time it has been carrying out a well defined plan of river improvement, including reforestation, improvement of mountain torrents, regulation of stream channels and construction of flood-prevention reservoirs.

The Commission has investigated 103 sites for storage reservoirs on the Elbe Basin in Bohemia. These reservoirs would have a total capacity of about 20,000,000,000 cu.ft. and would control a drainage area of abut 5840 sq.mi., or about 30% of the Bohemian Elbe Basin, which has an area of about 19,800 square miles.

It is calculated that this system of reservoirs would have stored one-quarter the total flood run-off of the Bohemian Elbe in the flood of 1890. The maximum discharge of 158,800 sec.-ft. would have been reduced by 56,500 sec.-ft., or to 102,300 sec.-ft., a reduction of 35.6 %. The maximum stage of 26.2 ft. would have been reduced to 19.7 ft., a reduction of 6.5 ft. A stage of 19.7 ft. is not usual, and does little damage. Ordinary floods of 19.7 ft. would be reduced to 11.5 feet.

Of these 103 projects, 23 have been decided upon, and six have been built or are under construction, including the two above described. These 23 projects will have a total capacity of about 5,000,000,000 cu.ft., and will control a total drainage area of 1730 sq.mi. Comparing the greater rainfall over their catchment areas with the average over the entire basin, their controlled area is equal to 2420 sq.mi., or to 12.2% of the entire Bohemian Elbe Basin.

It is estimated that these 23 reservoirs will reduce maximum floods on the main Elbe, above the German border, by about 1.3 ft. The reduction further upstream will, of course, be considerably greater.

The total cost of the 23 projects is $12,100,000. The cost of the six now built or under construction is $2,503,000; leaving $9,597,000 to be expended for the other 17, which will be built in the next few years, as money is made available by the government.

About 20% of the total capacity will be used to retain flood water for the increase of low-water flow. The other 80% will be kept empty for flood control.

The studies of the Commission show that a total storage capacity of about one-quarter the total capacity of the 103 projects above mentioned would, if used for that purpose, raise the low-water stage of the lower Bohemian Elbe to navigable stage for a month.

The South American Field

BY CYRUS T. BRADY, JR.*

SYNOPSIS—Many manufacturers and engineers in the United States are looking for opportunities to develop business in South America. The difficulties which must be met and overcome in order to do this are set forth by Mr. Brady from knowledge based on a personal experience of some years on engineering construction in various South American countries. He shows that while labor is cheap, materials are dear and the engineer from the United States must radically revise his standards of design and in many respects learn his business over again if he would succeed in South America.

There exists a widespread belief that South America is a continent of vast wealth in a sadly undeveloped condition, which awaits only the magic touch of the American engineer, or man of commerce, to pour forth streams of this wealth for their enrichment. This idea is very erroneous, at least in regard to the Argentine, Uruguay and Brazil, with the first of which this article is mainly concerned. The general conclusions deduced will, however, apply directly to the whole East Coast and in a less degree to Chile; or, in other words, to the great majority of the area and population of the continent. The information given will supplement the writer's letters published in ENGINEERING NEWS of Apr. 30 and Sept. 3 of this year.

As was stated in his last letter, the cost of living is very high in Buenos Aires. James Bryce, in his book on South America, has stated that he found it higher there than in

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St. Petersburg itself (or to be in fashion "Petrograd")—long known as the world's most expensive city. The cost is only slightly less in Montevideo and Rio. In some of the other cities of the three countries, the cost of food and lodging is lower, but clothing, amusements, books and other general expenses are on a par in all. The writer's personal experience extends to Salta, Tucuman, Santa Fé, Corrientes and Rosario, as well as Buenos Aires in the Argentine, to Montevideo in Uruguay, to Santos, Sao Paolo, Bahia and Rio de Janeiro in Brazil, and he has had many opportunities of conversing with men familiar with other cities.

Of course, in parts remote from the great cities, lodging and simple articles of food are cheaper; but all other expenses are greatly increased so that on the whole the cost of living with even a very modest amount of comfort is about a third higher than in the United States. The cost of living is but one factor which must be reckoned with. Accompanied by high custom duties, high rents, high wages of employees and the expenses attendant upon the giving of long-term credits, the cost of doing business is so high that only companies with large capital and with the most intelligent administrative ability are able to bear the burden of the development of their business. South America is slow to adopt new articles of commerce, and competition has been so keen that only the very best, considering both cost and quality, have established themselves. Yet, once established, it is difficult to dislodge them from favor. Many persons are apt to forget that there are already several American importing firms operating in South America in a more or less healthy economic condition and that they are much more likely to profit by our present lack of competition from Germany and Belgium than are newer organizations or representatives of manufacturers.

The average American engineer probably is not aware that some of the ablest European engineers have devoted much of their time to our sister continent and that many of their works will bear the closest scrutiny. To mention only one name: the Argentine Province of Mendoza years ago employed the famous Italian engineer, Cippoletti, to design a large number of irrigation works. Some of these works have since failed but the works which replaced them have profited by the dearly acquired experience. In this connection it should be noted that there are many irrigation systems built or building in Argentine, which, while not comparing in size with some of our gigantic Reclamation Service projects, will compare very favorably for detail.

The writer was employed by the Argentine Government on the design of the headworks for an irrigation system in the Province of Salta and was amazed at the thoroughness evidenced in the well made topographical surveys of the irrigable lands, the general survey of the entire drainage area, the careful investigation and solution of the complicated problem of the combination into one system of the existing irrigation water rights, and other details, legal or technical. Some of the existing irrigation systems have been in use for hundreds of years and practice has taught many lessons.

In all the southern cities the street railways are of the most approved types. Buenos Aires has a two-track subway five or six miles long, provided with a station where electric trains, of one of the railroads carrying much suburban traffic, interchange passengers with the subway trains. Directly underneath the subway runs a single-track tunnel by which the freight trains of the same railroad reach the port. The construction of this tunnel is being carried out in the most satisfactory manner by C. H. Walker & Co., the great English contractors, while the engineers of the subway were German and the work was done by Philip Holzmann & Co., also of Germany.

Of the ports it is unnecessary to speak at length as they have recently been described in ENGINEERING NEWS*. The port equipment is in general much superior to that of New York. Santos, Rio and Montevideo all have, in service or building, ports of the same excellence as those of the Argentine. Although much lighterage is done, especially in transporting goods from the steamers directly to factories or warehouses situated on water fronts, the great bulk of the freight is transferred by the most modern cargo-handling machinery. The ships tie up to massive masonry quay walls which are lined with extensive bonded warehouses, grain elevators, cattle pens and the like.

In the Argentine a type of river quay wharf which has given much satisfaction has been developed in timber or reinforced concrete. The accompanying sketch (Fig. 1) is merely diagrammatic but indicates the new type of construction in the Riachuelo of Buenos Aires, which is a canalized river with these quays lining the banks. The sketch also shows a pier of one of the three large transporter bridges across this stream. The caisson was made in place as it was being lowered, advantage having been taken of the permanent timber pile pier defenses to form a working staging. The piles were then driven and the caissons filled with a lean concrete. The work was designed and constructed by Messrs. Wayss & Freytag.

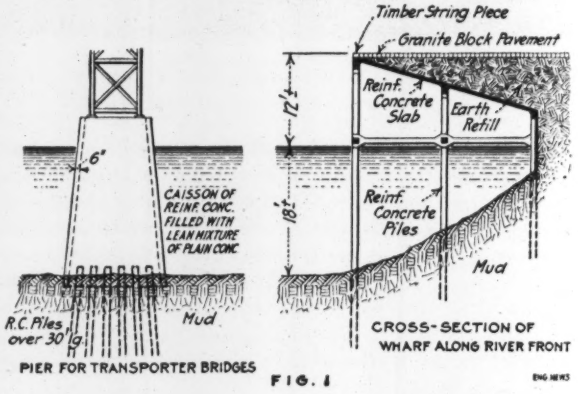
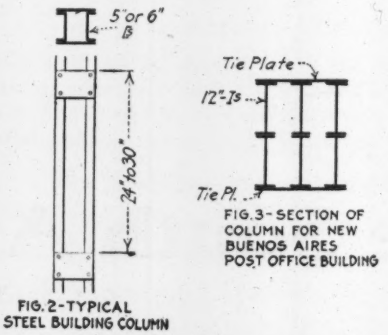


FIG. 1


5 or 6" ß
24' to 30'
Tie Plate
12"-13"
Tie Pl.
FIG. 3 - SECTION OF COLUMN FOR NEW BUENOS AIRES POST OFFICE BUILDING
FIG. 2 - TYPICAL STEEL BUILDING COLUMN

In reinforced-concrete building construction several bold projects have been accomplished, largely due to the initiative of the German contractors just mentioned and Philip Holzmann & Co. In Buenos Aires, the latter firm has built an arcade building the central portion

*Article by Fred Lavis in "Engineering News," of Jan. 29, 1914.

of which rises to sixteen stories. There are three or four concrete buildings in service, eight to ten stories high.

Steel building construction is carried out by European companies and by the export branch of the United States Steel Corporation. In addition there are two large and several small structural shops in Buenos Aires where fairly good work is turned out (from German or Belgian material), at a slightly higher cost than for imported steelwork. The writer remembers that on one occasion when 250 tons of grillage beams, cut to length and part of them punched for separators, were required, both companies agreed to deliver the work within 48 hr. This was, of course, sooner than the material was needed, as the bidders may have known, but the job was never held up an instant waiting for delivery; whereas the shipments arriving irregularly from foreign countries often cause delays on the work.

These delays and similar unavoidable annoyances are of constant occurrence in the export field and the greatest energy and tact are necessary in dealing with them. Americans as a race are well endowed with the former quality but are often criticized for their comparative lack of the latter, and this is much to be regretted as it is the quality above all others necessary in dealing with the Latin-American temperament. The importance of tact, or better, of understanding of and consideration for the customer, is felt not only in personal relations but in all forms of commercial activity.

To present this point more clearly a specific example will aid. It is a matter of almost common knowledge that the invoices, packing lists and so on, which accompany export shipments, are prepared by many American manufacturers in the most slovenly manner. Sometimes they are quite unintelligible to the customs broker in South America whose knowledge of American technical terms is always weak. An item like

1 Cr. Mark 312. Containing one Type A Former with No. 3 reverse bar hoop spider

means absolutely nothing to anyone except to the manufacturer who supplied it. This should be billed on the manifest as "Repair part for barrel-making machine" or something of the sort. In one instance, an experienced customs broker called upon the writer to explain whether the item

40,000 ft. 2 in. ammonia piping, with screwed fittings

should be declared as wrought iron or as cast iron, this classification being compulsory in the formal declaration to the customs officers. Doubtless to anyone familiar with the pipe trade the answer is self-evident, but it is not so to a customs broker. Another very embarrassing experience of no infrequent happening is that a box, which has been declared through a misunderstanding of the invoice to contain iron screws, may be found full of copper bolts, or other articles equally difficult of explanation to the customs officer.

The same principles apply to technical matters. Thus in bidding on a steel bridge it is not sufficient to inclose a blueprint stress sheet in a letter offering to furnish the fabricated steel only, for a certain lump sum, c.i.f. South American engineers are not accustomed to receive designs or to prepare them in this manner, nor do they care to let the contract for steelwork to one contractor, the erection to another, masonry and foundations to a third, surfacing to a fourth, etc. What is desired is a price for the bridge complete and ready to be opened to the public, thus including every cost connected with the work. Even were they disposed to contract for the steel as a separate item, the stress sheet with its usual scale in inches to the foot and its meager detail would fail to satisfy them.

Engineers in Europe and South America know very little of the practically standard details which any American structural shop turns out, as a rule, so satisfactorily. "American Railway Engineering Association Specifications" naturally means next to nothing to them. When they prepare designs of their own, large scale general drawings are furnished and amplified by details of particular points. A thesis invariably accompanies the drawings. This will contain a general description of the whole work and will discuss in detail the loads and stresses to be used. Methods of computation and design will be described and what amounts to an elaborate specification for materials, workmanship and construction will be given, followed by carefully estimated weights and other quantities. All the drawings and the thesis are usually bound together in a portfolio.

The cost of preparing designs in this style is, of course, considerable; but if competition of other enterprising contractors is to be met, it must be borne without reluctance. In passing it might be mentioned that, in one way, the theses often seem rather child-like. They always assume, tacitly, that the work being described is the first of its type ever conceived, and many self-evident details and even the commonest engineering formulas are developed at great length.

In competitive bidding with European firms a point of some difficulty concerning the columns often arises. In the first place, the sections used are wofully deficient from our point of view. The sketch (Fig. 2) shows the type usually employed in buildings. Fig. 3 is one proposed for the new post office of Buenos Aires, and the engineer of the American company which furnished the steel had great trouble in securing approval for his substituted design which was more in conformity with our standards. A second difficulty is the constant European use of Euler's formula. This formula does not reduce the stress below the allowable value in pure compression, for bridge or even building members of ordinary length. In Europe itself the building ordinances specify loads and stresses which are safe when used in connection with it. In South America where the stresses are commonly taken much higher, it allows loads which are too great; and it is useless to object as European practice is instantly referred to as final; the differences in the allowed stresses in pure compression are dismissed as being of little importance.

It should be evident from the examples cited that in placing any new engineering materials, or types of construction, or machinery, or other manufactured commodity on the South American market, much study must be given to types already in use, which are in any way similar to the one proposed, and to the desires and habits of the customer. What he wants and how he wants it should be the aim of every investigation. Only by following this method will success attend the effort to win his trade.

We have discussed the methods to be adopted more from the viewpoint of the American exporter than from that of the engineer or capitalist interested in engineering works. One of the topics of most interest to these two classes is,

of course, the labor situation. It has been said epigrammatically that in the Argentine the labor of the country is Italian, the shopkeepers Spanish, the commerce English and German, the culture French, and that the only occupation of the natives is selling land to foreigners or borrowing money on what remains in their possession. Were this statement perfectly true, it would be a simple matter for engineering companies to carry on their work, for there seems no part of the earth where Italian labor is not familiar and appreciated.

Unfortunately, the situation is much more complicated since the laborers in fact come from all the nations, from Scandinavia to Asia Minor. A personal experience will indicate the complexity of the situations which must be met daily by an engineer on construction work. On a certain reinforced-concrete, steel-frame building, the foundation contractor was a Frenchman and his foreman an Italian; the concrete work was done by a German firm with German and Italian foremen; the structural steel was supplied by an English company and erected by a superintendent hailing from Gibralter, assisted by Spanish foremen; the electrical equipment was installed by an American concern under that great rarity, an Argentine foreman; and this variety of nationality extended to the other subcontractors.

Constant friction arose between the Germans and the Spaniards, and most of the writer's time was taken in smoothing out the differences and in trying to induce the disputants to apply the energy used in their quarrels to the furtherance of the job. This is a task which permits a man to make use of all the tact and knowledge of human nature which he chances to possess; and, in so far as he is successful, returns to him the greatest reward the engineering profession offers—the keen pleasure of the management of men.

It will be profitable to enlarge on the labor question and the following approximate list of the wages prevailing in Buenos Aires may be useful. All are given in American cents per hour. The common day's work on construction is 10 hours, although stevedores and some other trades work but eight.

Common labor, 12 to 14
Concrete laborers, 15 to 17
"Hammer and saw" men, 17 to 19
Carpenters, 19 to 21
Mechanics, such as machinists, ordinary bricklayers, structural workers, etc., 20 to 25
Stevedores, 22
Specially skilled mechanics, such as cement floor finishers, etc., 25 to 30
Foremen, depending on trade, etc., $65 to $100 per mo.

In rural districts, where labor is largely agricultural, the day's wage is usually about $1.25 with food, or $1.75 without. In undeveloped districts, such as the province of La Rioja, the figures shrink to about 85c. to $1.10.

These rates will certainly seem astonishingly low to most Americans, but the writer took notes in many parts of the country and vouches for them. They are so low that the best class of European mechanic has not been attracted and the quality of workmanship suffers from their lack, so that constant and close supervision is imperative on work of any magnitude. Argentines, that is natives, have found agricultural and similar occupations more profitable than the common trades, and it is unusual to find good mechanics among them.

The corollary to be drawn from the table given is that labor-saving machinery has a smaller field south of the equator than in the northern hemisphere. There follows another table showing the detailed cost to the contractor, without profit, of ordinary reinforced-concrete building work in Buenos Aires. The table is an average of several buildings and is rather low than high.

Cement, 1.5 bbl. @ 3.50	$5.25
Gravel, 0.9 cu.yd. @ 3.50	3.15
Sand, 0.45 cu.yd. @ 1.55	0.70
Labor mixing and placing	1.80
Superintendence	0.40
Forms, labor and material	3.50
Reinforcement in place, 125 lb. @ 2.8c.	3.40
Power, light, water, incidentals	1.50
Plant, development and depreciation, etc.	1.00
Interest, insurance, clerical expenses	1.00
Cost, without profit, per cubic yard	$21.70

It will be noticed that the labor costs are much lower than those of materials, and this will explain why many of the devices and methods used in other countries to dispense with extra labor have not come into general use here. The lessons drawn from the two tables may be extended to other fields of engineering work. Hand labor and horses are so cheap that, regardless of their rather low efficiency, machinery must be of a very exceptional usefulness to supplant them.

Even in the field of railroad construction, hand labor and horse-drawn vehicles or equipment are the rule. The vast plains of Argentine are broken by so few hills or elevations that large cuts and fills are far apart and steam shovels would soon "eat off their heads" in general charges while moving long distances to excavate out small yardages in any one spot.

On the other hand an enterprising American contracting engineer has had much more work offered him in Santa Fé province than he is able to carry out with his American ditch-digging machine. There are enormous tracts of semiswamp lands along the Rivers Plate and Parana, which only require drainage to be most productive, and here this type of machine has proved more economical than hand labor.

One or two makes of concrete mixers are already in use, and their sale and that of other good types can be extended. Concrete distributing machinery could also be introduced with profit to replace the present method of heavy ½-yd. skips running on 24 or 36-in. gage track. Large automobile trucks are rapidly increasing in number in cities, for there the cost of maintenance of horses is greater. A few road rollers are to be seen; naturally only in the cities, as the country roads are almost entirely unsurfaced. Scrapers and drags might be introduced to care for these. Small pumping plants could be installed in many places where the omnipresent windmill does not render sufficient supply. Taking advantage of the present cessation of German and Belgian competition, our trade in electrical supplies and in light, power and street-railway plants and equipment can be increased. Many inquiries for structural steel and cement have already been received. We have developed a healthy commerce in steam-railway equipment, and it can be improved. The hint is offered to our manufacturers to construct their product when possible, so as to resemble more closely the details of the European types with which they are in competition and thus seem less strange to their purchasers. It is not necessary even to mention the great sale of our agricultural machinery.

In the introduction of American methods of construction, the most important point would be to obtain suitable foremen, since high-grade American mechanics, at least up to the present, have not found any advantages in the Argentine more desirable than those of their own country. In the United States the whole tendency is toward econ-

omy of labor, rather than of material, and we have seen that practically the reverse is true in Latin-America. Still it is patent that where engineering competition is so keen, any saving in labor would be of value. A few months since, shortly after the writer's return home, he was privileged to inspect closely a concrete warehouse being built by the Turner Construction Co. His instant remark was, "If you chaps were to go to South America, you could put every other contractor there out of business." Whether such a prophecy could be realized would depend very largely on the successful solution of many of the administrative matters mentioned in this discussion and on others, such as ability to play politics, or to keep out of them, when necessary.

The North American product which will prove of greatest value in South America is not some special type of machinery, but rather the type of man who can understand the character of its people.

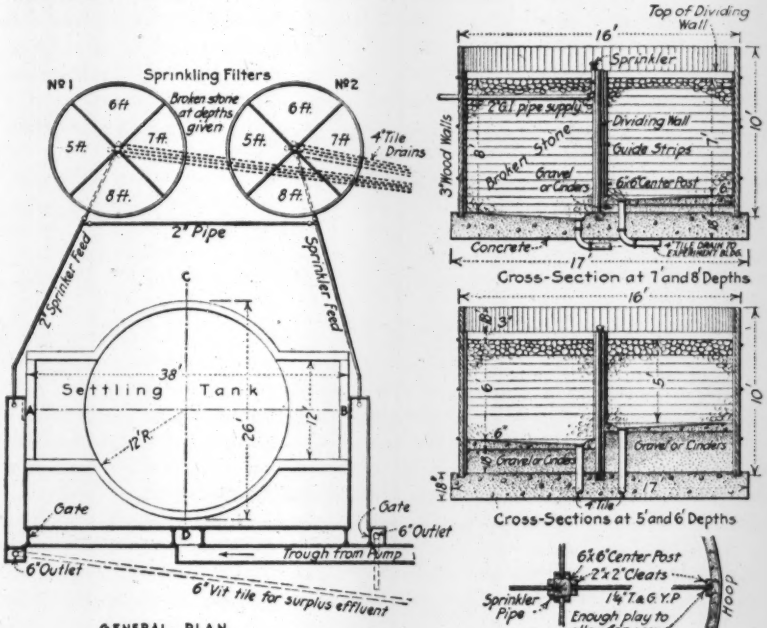


Fig. 1

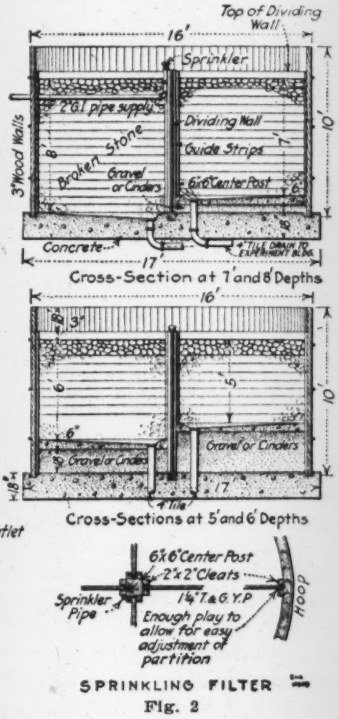


Fig. 2

EXPERIMENTAL SEWAGE-TREATMENT PLANT, INDIANAPOLIS, IND.

Experimental Sewage Treatment Plant at Indianapolis

The city of Indianapolis, Ind., has for some time been considering the question of sewage treatment in order to avoid the present pollution of White River, and during 1913 an experimental plant was built. This consists of an Imhoff settling tank, two sprinkling filters, an electrolytic tank, and a laboratory building. This plant is located near a 6-ft. sewer, from which the sewage is taken as required, and to which the effluent is returned. The electrolytic process was found unsuitable to the character of the effluent and has been abandoned.

The city, with a population of 250,000, has an average total daily discharge of 44,000,000 gal. of sewage and trade wastes (into White River), and the experimental plant has a capacity for treating 240,000 gal. daily. It was put in service in March and will be operated for about 12 months, after which the question of a permanent plant will be considered. The fact that the sewage contains a rather high percentage of trade wastes is a special factor in determining the most satisfactory treatment.

A plan of the plant is shown in Fig. 1. The 6-ft. circular sewer is divided into two rectangular channels 3 ft. wide. One of these has a double set of inclined bar screens to remove the solids, and from this the sewage is pumped. This channel can be shut off by a gate, and the other channel serves as a bypass. The sewage is pumped to a wood trough fitted with gates, and is delivered first to a settling tank of the Imhoff type, rectangular on top (36x24 ft.) and having a circular sludge chamber 24 ft. diameter. The total depth is about 33 ft. An 8-in. pipe extends to the bottom of the chamber. The tank is of reinforced concrete, but considerable trouble was experienced with leaks, and extra time and work was necessary to get it watertight. The upper portion is fitted with steel baffle plates.

The effluent from the settling tank flows by gravity through 2-in. galvanized pipes to the sprinkling filters, 8 ft. diameter, shown in detail in Fig. 2. They are of wood construction, each divided into four compartments filled with broken limestone of 1½-in. size in one filler and 2-in. in the other. The depth of stone varies from 5 ft. to 8 ft., to determine the effects of different depths. The bottom is of concrete with gravel fill and concrete floor for the shallower compartments. The two tanks are identical in construction and are used alternately. The 2-in. supply pipe ends in a sprinkler head, and each compartment has a 4-in. vitrified tile drain leading the effluent to a sampling tank in the laboratory building, which is built over the sewer.

A typical analysis of the sewage is as follows: organic nitrogen, 21.4 parts per million; free ammonia, 6.6; nitrite-nitrate, 1.0; oxygen, 34.0; chlorine, 122.0; suspended matter, 200.

The plant was designed and built under the direction of H. W. Klausmann, then City Engineer, but has been modified by B. J. T. Jeup, the present City Engineer. When put in operation it was inspected by Geo. W. Fuller, as consulting engineer for the city, and he will make the necessary study of the results in relation to the design of the permanent plant. The operation is under the charge of H.C. Underwood, City Chemist.

A Wireless Telephone System is being installed by the Union Pacific R.R. for communication with its overland trains. There will be stations at Grand Island and North Platte, Neb., Cheyenne and Green River, Wyo., and Ogden, Utah. High towers and heavy sending equipment (5- and 10-kw.) will be used to overcome communication difficulties in the Rocky Mountains.

The Relation of Geology to Railway-Tunnel Location*

By Edwin C. Eckel†

Most railway tunnels are so located as to pass through a barrier range at some relatively low point. The railroad was headed for a gap or pass through the range in order to secure as low a crossing point as possible, and the tunnel represents an effort to make a little further reduction in the elevation of the crossing point.

The fact that a gap or pass exists at a certain point in a mountain range is not a matter of accident; there is always a cause for its location at that particular point.

Fig. 1. Gap Caused by Erosion of Softer Rock

Fig. 2. Gap Caused by Erosion of Weak Crest of Arch or Anticlinal Fold

Fig. 3. Gap Caused by Erosion along Weakened Fault Plane

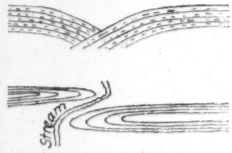


Fig. 4. Gap Due to Overlapping Folds

In most cases, it is possible to say, after study of the case in the field, that the pass owes its location to some peculiarity in the structure or composition of the rocks at that point.

Other things being equal, depressions along a mountain ridge are likely to occur where soft or soluble rocks reach the ground surface. If the rocks of the range are so placed that a depression of this kind extends at right angles to the range, it may in time be extended entirely across it, giving rise to a gap. Fig. 1 illustrates a hypothetical case of this kind, where a series of limestones, inclosed by harder rocks, have been worn down below the general crest level. On a small scale, gaps owing their origin to this cause are fairly common,

A second cause is erosion of the crest of an arch or anticline. Fracturing is common at this point during the folding of the rocks, and the weakness thus induced may at a later date give rise to deep erosion along the weakened zone, and the ultimate formation of a gap across a ridge. This is illustrated in Fig. 2, showing a condition which could be readily duplicated in many parts of the South.

Faulting on a large scale also causes zones of weakness and easy erosion, and gaps may arise from this cause, as shown in Fig. 3. In many cases, where a gap or pass is located along a fault zone, we have to deal not only with such weakness as may have been the direct result of faulting, but with the fact that the fault may have brought into contact at the surface two sets of rocks differing widely in hardness and resistance to weathering. In such cases, the gap is due to the indirect effects of the fault, rather than to the direct structural weakness.

Another very common type of gap, particularly in certain portions of the southern Appalachian region, is that caused by the arrangement of the rock folds and, consequently, of the mountain masses. This can be seen best along the line of the Chesapeake & Ohio R.R. in the section near the Virginia-West Virginia state boundary, where examples are encountered at frequent intervals. The rocks in this area are arranged in steep folds, and in most cases the mountain ridges represent actual arches or anticlines in the underlying rocks. Cross folding at intervals causes an *echelon* arrangement of the ridges, and the roads and streams follow through around the ends of these ridges at relatively low crossings. Fig. 4 is an attempt to suggest the main features of this sort of topography.

If the entire ridge which has to be tunneled were composed of one kind of rock, if the structure of this rock were everywhere uniform, and if no faults or other dislocations existed, it would, of course, make little difference where the tunnel was driven. Such homogeneous rock-masses are frequently found in textbooks, but they are really quite rare in the outside world. Usually the engineer will find, on examining the ridge which faces him, that it is made up of several distinct kinds of rock, that these kinds of rock differ in hardness and other physical characters, and that different portions of the ridge probably show differences in the formation of the rocks. All of these facts will have some bearing on the cost of driving and operating the proposed tunnel; and it will be well to get some idea in advance as to how the ground conditions can be made to fit in best with the other requirements of the line. If a relatively slight shift in alignment is going to give cheaper work, either in constructing or operating, without bringing in any serious new difficulties, it will certainly pay to make the change.

Shale—Cutting through shale usually means fast driving and cheap extraction, for the material breaks so readily that the quantity extracted per man or per pound of powder is commonly far higher than in any other rock. But when this is said, all the advantages have been mentioned. The final completion of the tunnel may be dangerous and expensive, and the cost of maintenance may turn out very high unless it is completely lined at once. In some cases, timbering must follow up close behind the heading, in order to prevent falling fragments and to retain the roof line. Shale is ordinarily full of closely set joint planes. On a freshly exposed surface, these may not show markedly, but exposure to the air induces "slaking," the joints open, and the shale breaks into fragments. Further than this, water is apt to be carried in quantity along some of the more strongly marked joint planes.

Slate—The material reported as slate in the progress of the work may be a real roofing slate, but it is more apt to be a dense shale, breaking out in tabular masses instead of irregular fragments. In either case the driving is easy if the bedding or cleavage are in such an attitude that advantage can be taken of them; but work across the grain is difficult and expensive. There is less frequency of falls of roof during working than in dealing with other shales, but on the other hand the size of the

*Extracts from a forthcoming book on "Geology as Applied to Engineering Work."

†Assoc. Am. Soc. C. E., Consulting Geologist, Munsey Bldg., Washington, D. C.

falling masses makes the matter more serious when it does happen. If the bedding is vertical or nearly so, lining will usually be unnecessary; if the bedding is horizontal, falls may be expected to occur at intervals. The importance of the tunnel will then have to determine whether all of these should be guarded against from the outset.

SANDSTONE—Sandstones vary widely in physical properties, from thin-bedded fragile materials that can be readily broken with a pick up to dense vitreous quartzites that will wreck all the tool steel on the job.

Quartzites are sandstones in which the original quartz grains have been cemented together by infiltrating silica. They are dense, resistant to physical and chemical changes, difficult and expensive to excavate. Fortunately, they occur principally in regions of extreme metamorphism, and are therefore common only in certain mountainous portions near the eastern and western coasts, and in the Lake Superior region. In steeply folded regions, the quartzites may be barely jointed. In this case their excavation is easier, but at the same time the joint planes give access to water.

Throughout most of the central and eastern United States, the sandstones found are reasonably dense, varying from stones like the Berea stone up to the much denser and tougher bluestones or flagstones. They give fairly cheap driving, especially where the bedding is in a favorable attitude, and make excellent roofs and sides. Taken as a group, sandstones of this intermediate type probably furnish the cheapest tunnel work, when construction and maintenance both are considered.

West of the 95th meridian, most of the sandstones encountered in the plains region and along the immediate Pacific coast are fragile, thin-bedded materials, readily excavated and yet commonly strong enough to hold position after the cut is driven.

GNEISS—The banded metamorphic rocks, such as gneiss, schist, etc., will differ greatly in difficulty of treatment, the variations being due not so much to differences in mineral or chemical composition, as to the attitude of their banding or apparent bedding planes, the thickness of the plates or beds into which they are separated, and the presence and relative importance of joints. A gneiss lying horizontally or nearly so, and without frequent joints or thin banding, is perhaps more expensive to handle than any granite. On the other hand, a gneiss or schist whose banding is at right angles to the course of the heading will commonly break almost as readily as flagstone. In any case, except where joints are very numerous and open, the roof and sides will be secure. Water softening with lime and then allowing the turbidity to settle out, along with the precipitated carbonates. Turbid water has never been successfully disinfected with hypochlorite, because the bacteria imbedded in the suspended matter are not destroyed.

(7) The sterilizing action persists indefinitely. In a paper on water disinfection by chemical methods, Samuel Rideal states the advantages of using chemicals that persist in their disinfecting action, in the following words: may enter either along the apparent bedding planes, or along joint planes; but ordinarily the quantity will not be serious.

GRANITE—For convenience, all of the massive igneous rocks may be included here under this heading, and as a matter of fact most of them will be true granites or closely allied. Under ordinary circumstances, rock of this type will afford very expensive excavation, but good sound roofs and sides, and practically no water troubles. One point is worth bearing in mind. Granites do not have any bedding planes, and ordinarily show little banding or foliation. But even the densest and most massive looking granite will break with considerably greater ease in one direction than in another. This direction can only be found by experiment in each case, but it is worth going to this trouble early in the work in order to secure extra efficiency in drilling and blasting operations later.

LIMESTONE—Limestones differ from all the roofs which have heretofore been mentioned, in a very striking and important way. The other rocks, from shales to granites, weather chiefly or entirely from an exposed surface, so that if the rocks exposed on the ground above the tunnel alignment seem fresh, there need be little fear of striking decayed rock in the headings. But limestone acts differently. It is very soluble, and water penetrating along joint planes or through the mass of the rock itself will gradually work out large channels or cavities to a great depth. These may remain open, or be partly filled up by "clay seams."

Limestone is an easily handled rock, and a sound thick-bedded limestone will make for cheap driving and good roofs and sides. But in driving a limestone tunnel there is always the chance that the next blast will play havoc with all calculations by opening up a clay seam, a cave, or a water channel. The difficulty is not so much the increased expense, as the fact that the interruptions are unexpected and so hard to guard against in advance.

Owing to differences in composition, texture, bedding, position and climate, limestones show wide differences in solubility and cavity formation. Other things being equal, caves and large water channels are most likely to occur in a limestone lying horizontally or nearly so. On the other hand, steeply dipping limestones will frequently show clay seams extending from the surface downward for 50 ft. or more.

These facts may be used for guidance. If the ridge consists partly or entirely of flat-lying limestone beds, the presence of known caves in the same general region, or the existence of exceptionally large springs breaking out along the flanks of the ridge, should serve as a warning. On the other hand, if the beds dip at angles of 35° or more, attention should be paid to their appearance along a line across the ridge over the tunnel alignment. The occurrence of bands of red or deep yellow clay, apparently interbedded with sound limestone, will in that case suggest that these seams may go deep enough to be encountered in the tunnel work.

ROCK FOLDS—It is but rarely that a tunnel passes through rock beds lying flat or nearly so, because low points in ridges do not usually occur in areas of horizontal and undisturbed rocks. Normally, the rocks will be dipping at fairly high angles, which may indeed approach the vertical. Normally, also, the strike or trend of the rocks will be more nearly at right angles to the course of the tunnel than parallel to it. These conditions arise from the general modes of origin of mountain ranges and passes

Whatever the angle of dip, the rocks will break most readily from a bedding plane, slips and falls will commonly originate on such planes, and the chief water flows may be expected along them. The presence of numerous

or very open joints may, however, operate to modify these conclusions. So far as work is concerned, if the rock beds dip parallel to the side of the ridge, the blasting will be least effective, and the water troubles greatest; if the rocks on the contrary dip into the mountain, the excavation work will be cheapest, though perhaps more dangerous; while the chance of heavy water flows will usually be slight. The chance of falls or slips will be least with horizontal or vertical rocks, and greatest with rocks dipping between 35 and 70° or thereabout. Of course, allowances must be made, in reaching conclusions, for variations in the thickness of the individual beds, and for differences in the tightness or openness of the bedding planes.

Contact Planes—All of the features which characterize ordinary bedding planes are emphasized on those planes where two different kinds of rock are brought into contact. The chance of slipping and the possibility of water troubles are both present at such points. This is true even where the contact is an ordinary conformable one, both rocks having the same dip; it becomes still more important where the contact plane is marked by faulting.

Fault Planes—Since the existence of a fault implies that there has been movement along its plane, the rocks on one side having been raised or lowered relatively to those on the other side, it can be seen that the fault plane and the zone of rock in its immediate vicinity are likely to offer engineering difficulties. When fracturing or brecciation of the rocks has accompanied the faulting, the effects may extend over a considerable zone, and their technical importance may be heavily increased. But even where there is no serious rock fracturing, the fault plane itself offers opportunities for easy rock movement, which may vary in intensity from simple roof falls to serious slips. And, in addition, the plane of the fault is likely to offer an easy passage for surface and subsurface waters.

For these reasons, a faulted zone is not likely to give cheap and safe tunnel driving, or cheap maintenance; and if it is possible to detect the presence of fault in advance, and locate its position on the ground, it will pay to go to considerable trouble to avoid its neighborhood, by shifts in either alignment or level.

The Reclamation of the Zuider Zee

By J. M. Figee*

The long contemplated reclamation of the Zuider Zee, the inland sea making into the north coast of Holland, was just about to be started when the present European War broke out. Whether it is to be carried out now or whether it is to lapse for another 20 years while Europe regains its balance, it remains a most interesting engineering problem. The first complete plan for the project was made in 1866, and this was recognized by the government to the extent of appointing investigating committees in 1870. There followed then a series of plans culminating in those of 1891 and 1894,† since which time the project has been constantly growing in favor until in September, 1913, the Government announced its intention to begin the work along the plans suggested in the 1894 report, with the necessary modernization of detail. This final scheme will be described below.

*118 Shaw Ave., Dayton, O.

†See "Engineering News," Oct. 25, 1894, p. 336.

Details of Scheme

The Zuider Zee (Fig. 1) covers a total area of 2600 sq.mi. The plans approved by the Government provide for a main dike across the mouth of the sea, with a number of subsidiary dikes inclosing 770 sq.mi. of "polders,"*

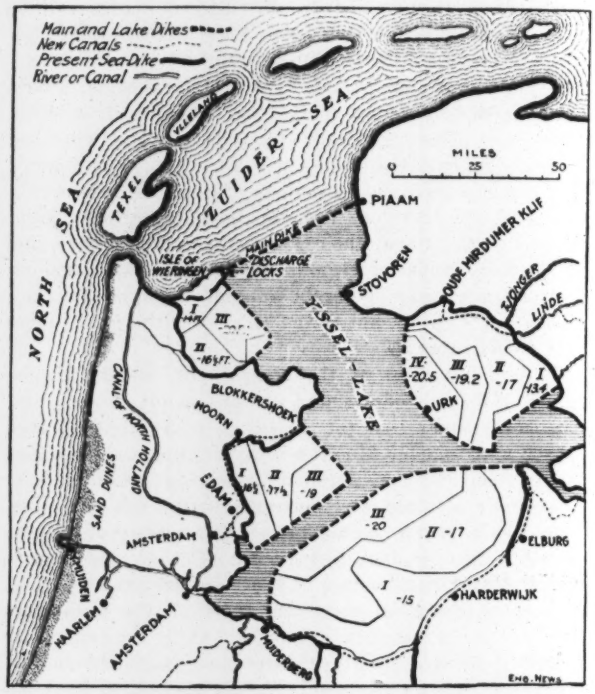


Fig. 1. The Zuider Zee, Holland, Showing the Reclamation Scheme about to Be Undertaken

which will be drained and used for agricultural purposes. Between the polders and the main dike is to be formed a fresh-water lake of 800 sq.mi., to serve as a reservoir for the Yssel River.

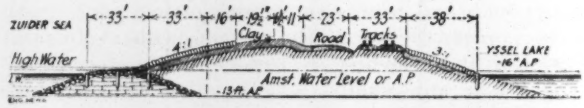


Fig. 2. Section through Main Dike across Mouth of Zuider Zee

The main dike, separating the lake from the sea, will have a length of 18 mi. and an average width of 325 ft., with a height of 17 ft. above the Amsterdam water mark (Fig. 2). This dike will be in water of an average depth of 10½ ft. below Amsterdam water mark, while the deepest place will be as much as 20 ft. below that datum.

Thirty-three years will be required to complete the work, at a cost of $90,000,000, not including the interest, or $130,000,000, including the interest. Instead of the present annual revenue of $800,000 derived from the Zuider Zee fishing industry, it is estimated that agriculture will yield a revenue of about $28,000,000 annually.

*Polder, a Dutch word which has been anglicized and which is defined as "a tract of low land reclaimed from the sea by dikes."

Main Dike

The main dike will connect Ewyksluis, in the province of North Holland, with the Island of Wieringen, and from there will go northeast to the little city of Piaam, in the province of Friesland. The deepest channel is 35 ft., between Wieringen and North Holland, while the deepest place between Wieringen and Friesland is 20 ft. It is planned to construct a little island of brushwood, revetment, and stone half-way between Wieringen and Friesland on the sandbank Breezand, with a berm of 250 ft. The connection of this island with the coasts of Wieringen will be the next undertaking.

The dike is to be constructed with its toe against a dam (Fig. 2), a necessary means to assure the best possible footing for so long a dike. This dam, which will be built in layers, will have its crest at low-water mark. The toe will assure a solid footing for the main dike, which, with the layer of stones and the anchoring with piles, makes it impossible for it to wash away.

The base of the toe dam will be approximately 100 ft. On and against this dam will be built the actual dike, with sand which will probably be dredged from the Zuider Zee. The outer slope, 1 on 4, will have a solid stone paving up to a height of +15½ ft. A. P.; then a layer of clay 3½ ft. thick to the top of the dike, which will have a width of 7 ft. Then will follow the first inner slope, 1 on 2½ (no stone covering), a driveway of 23 ft., a double-track railroad requiring a width of 33 ft. and a second inner slope 1 on 3, having a heavy stone paving and a 3½-ft. layer of clay to 1 ft. 4 in. below A. P., the adopted water level of the Yssel Lake.

In building the main dike, it is proposed to first fill up all the lower part; which preparatory work of evening up the bed of the dike should be accomplished without any difficulty. The sand being dumped out in large quantity at several places at the same time, will fall with its natural slope forming a very wide base, which certainly will increase the solidity of the foot of the dike. Two continuous layers, forming a so called sink-plate, will anchor the base permanently. Then while the dike is being built up on top of this anchored base, the outside scope will be protected against the onrushing waters of the sea with large stones.

The most difficult part will be in the meeting of the four dikes, built from the temporary island half-way between Piaam and Wieringen, to either side, and also from Wieringen and Piaam toward that island. When a certain opening is reached, the head ends of these dikes will be protected by a massive concrete block. The next problem will be the placing of a number of concrete boxes measuring 160 ft. long by 16 ft. wide and 16 ft. high, about 145 ft. apart. These boxes, which will be made with partitions, will be towed to the proper place, then filled with sand, and in this way lowered to the bottom. Sand will be deposited on both sides. The weight of each will be approximately 2000 tons. In this way the opening will be reduced by about 50%. A second row of concrete boxes of the same dimensions will be deposited beside the first ones, but in such a way that they cover the open spaces of 145 ft. left by the other row of boxes, and also overlap about 7 ft. on each side. In this way, by means of this massive row of concrete boxes, the opening between the dikes will close up.

In order to prevent the forming of dangerous rapids when closing the last few openings, it will be necessary to wait for a very quiet day to close up the last twenty or so openings, and even then it is very doubtful if the remaining opening between the dikes can be filled up in one season. A great many concrete boxes will have to be used, and there is a possibility that the closing up of the opening will not be completed before fall and winter set in, which may result in the wrecking of some of the work. But once the concrete blocks are all set in their right place, the completion of the remainder of the dike is merely a matter of time.

Polders

There will be four polders within the dike. They will be known as the Northwestern Drainage or the Wieringer Lake, with an area of 80 sq.mi.; the Southwestern Drainage or Hoornsche Hop (120 sq.mi.); the Southeastern Drainage (405 sq.mi.); and last the Northeastern Drainage (195 sq.mi.). Each will be subdivided into smaller areas, as shown in Fig. 1, with varying depths for each subdivision. These subpolders, as one might call them, will be separated by dikes or quays, with locks where various canals intersect these quays. This division has a great advantage, in that it will be possible to first drain the most shallow subpolders and get them properly treated and prepared.

Each subpolder will have its own steam pump, the capacity of each being calculated as follows: 12 hp. per 1000 hectares (2470 acres) for each meter (3.28 ft.) lift (approximately 1.15 hp. per 1000 acres for each foot lift). Considering the fact that the water must be pumped up to 16 in. above the normal water mark of the new lake, the combined power of the various steam pumps for the four main polders will be approximately 17,000 hp. These pumps will have to be kept in perfect condition at all times, owing to the fact that they must do continuous duty, especially during the rainy season in spring, in order to keep the level of the various canals of the subpolders up to the proper height. The total area drained will be 800 sq.mi., of which 725 sq.mi. is first-class clay ground. Fifteen steam pumps will be required, one for each subpolder.

A fresh-water lake will be formed within the dike, known as the Yssel Lake, thus solving the hard problem of what disposition to make of the River Yssel, which will flow into this lake. Thirty discharging sluices, each having a width of 33 ft., will form the connection between the lake and the Zuider Zee. It is proposed to build a discharging canal, 3200 ft. wide, at the east end of the Island of Wieringen, increasing to 3930 ft. at the Zuider Zee side, with a depth of 16 ft., while near the Yssel Lake, the width will be 4875 ft. At the Zuider Zee end, there will be located five groups of six discharging sluices each, with lock sills at a depth of 13 ft. below the water mark of the lake. Besides this discharging canal, there will be a canal 500 ft. wide, with two locks, one 35 ft. wide, and the other 20 ft. wide. The size of the lake is calculated to give ample storage room for Yssel water even if high seas and a high river level render it impossible to open the discharging sluices, for three days, a combination of circumstances which is not likely to occur.

The dikes along the lake, which will not be of such massive construction as the main dike, will have their crests at from +8 ft. A. P. to +11½ ft. A. P.

A very careful examination of the water level of the

Zuider Zee was necessary before it was possible to place the proposed normal level of the Yssel Lake at —16 in. A. P. Of course, it will not be possible to always keep the water level to the normal mark, because of various natural conditions, such as high winds or unexpected high water in the River Yssel, but the variation will never amount to much. It will always be possible to prevent a lower level than the proposed by a well regulated valve system in the discharging locks.

New Canals

On account of the location of the main dike and the four main polders, it is necessary to provide for new discharge canals in a few provinces. These are shown on the map in Fig. 1.

Benefits of Scheme

Navigation on the Zuider Zee will be greatly benefited by the diking, as the proposed water level will insure a level high enough to make navigation safe. It will also be a great benefit by facilitating the discharge of most of the rivers and polders, which in some depends entirely on a low level of the Zuider Zee, with the result that these are overflowed during high water, and are damaged by the Zuider Zee water which is harmful to grass land. Then again, in the course of a few years, the Yssel Lake will have fresh water, which will mean that the small streams and canals will also contain fresh water, especially in Friesland. Furthermore, there will be a short railroad connection between the northern part of North Holland and Friesland.

The main gain will be a very fertile piece of ground with an area of approximately 800 sq.mi. Figuring about ¼ sq.mi. for one farmer and his family, this new province will give homes to not less than 40,000 families, or about 200,000 people. To this can be added about 50%, to take care of the tradespeople of various classes, doctors, teachers, etc., who will make this new province their home. In all, this reclaimed land should furnish homes for between 300,000 and 400,000 people.

It is calculated that the main dike will be completed in 9 years. From the fifth to the ninth year, improvements will be made on several harbors, and the Zwolsche Diep with the two draining levees, as well as the canal from Hiaam to Harlinggen in the province of Friesland will be completed.

In the 14th year, the Northwestern Drainage will be completed; in the 21st year, the Southeastern Drainage; seven years later the Southwestern Drainage, and in the 33rd year, the total work on this great project will be finished. The government, however, will hold the reclaimed land for two or three years before leasing it out to farmers.

A Large Hand-Built Earth Dam, "Mammoth Reservoir," Price, Utah.

By J. C. Wheelon*

Reservoir—Mammoth reservoir, which supplies the impounded waters for the Price River Irrigation Co.'s canals in Carbon and Emmery counties, Utah, is situated in San Pete County, 12 miles east of the town of Fairview, and is up in the mountains at an elevation of 8000 ft. above sea level. The basin in which the waters are impounded, lies in the apex of the Wasatch mountains, at a point where this range forms the divide between the Great Salt Lake basin and the Great Colorado River water-shed, and of which stream the Price River is a tributary. The waters released from this reservoir travel down Gooseberry Creek 24 miles to the town of Colton, on the Denver & Rio Grande R.R., and thence down Price River to the diversion dam, some five miles above the city of Price.

Dam Site—The dam, which is being constructed to impound the waters of Upper Gooseberry Creek, is located in a cañon, the side slopes of which are composed of a glacial flow. The clay and rocks seem to have moved but a short distance as the rocks are worn but little and ledges of some extent are almost intact. The clay and fine gravel have formed a soil covering on the cañon slopes and is of fine quality for use in the construction of an earthen dam. The bed rock is found only a few feet below the bed of the creek and upon this the discharge tunnel, 5x7 ft. in section, was built, connecting the feeding tower in the reservoir with the creek on the downstream side of the dam.

General Design—The dam is designed to be 125 ft. in height, eventually, and is built of earth on both sides of a concrete center core wall. The core has buttresses on both sides opposite each other, starting 20 ft. wide at bed rock and tapering on a batter to zero at the top of the dam, and spaced 20 ft. apart along the wall. The dam is being built only so fast as the irrigation demands of the farming district require; it has been six years under construction; and, is now at the 67-ft. level. The present area of the dam covers one-sixth of an acre.

Peep Wells—Two peep wells, composed of 7¾-in. casing pipe, are carried up through the dam, one on the upstream side of the core wall and one on the downstream side, each about 6 ft. from the core and near the center of the dam. The bottom end of each starts at about the 30 ft. level. They were started by placing a pad of sand and gravel of the proportions for concrete but without the cement or water. This pad was made 4 ft. thick by 6 ft. square on the earth dam. A grillage of ½-in. rods, 3 ft. long, was laid on this pad, the rods being set 2 in. apart. Upon this grillage, the open end of a section of pipe was set, the top being braced in a vertical position; then, as the earth was carried up the next lobe, the pipe was filled with the sand and gravel to about 3 ft. above the lower end. From this point on, the earth was tamped up to the outside of the pipe the same as on any other portion of the work. These wells will be carried to the top of the dam, and each will be fitted with cap and float. These wells are designed to indicate the line of saturation in the interior of the dam.

Springs—Several springs were encountered during construction. Those in the bottom of the gulch were capped with concrete and the water conducted to the outlet tunnel in iron pipe, while those encountered up the hill slopes were excavated so the cavity could be filled up with gravel, capped with concrete and conducted in burnt-tile drains, laid in trenches in the natural hill ground and carried well below the area covered by the dam. Those springs which developed on the upstream side of the core wall were conducted to and through the core wall in a concrete-covered gravel filter, and thence to the outside, as above described.

*Consulting Engineer, Garland, Utah.

EARTH FILL—The first work on the earthen fill was carried to the 15-ft. level by dump wagons, the earth being rolled with a corrugated roller of eight tons weight, drawn by four horses. The next 25 ft. was carried on by water. A ditch carried water along the brow of the hillside 150 ft. higher than the work. Teams and plows would make furrows straight down the hill slope from the ditch to the work level on the dam. A small quantity of water released from the ditch into the furrow washed the entire furrow upon the dam, while the teams were coming back up the hill to engage another furrow. The free water was carried off the work in an improvised culvert through a dike at the extreme up- and downstream faces of the dam, which was carried a few feet higher than the puddled lobe and thus impounded it. This method was found objectionable because the heavy and coarser material, weighing 2100 lb. per cu.yd., dry, would repose next to the hillside, while the very fine clay, weighing 1500 lb. per cu.yd., dry, would carry in suspension to the center lobe of the work. It was found so difficult to extract the water from this fine clay that the sluicing process was abandoned and rock and gravel were thrown into this puddled and bottomless mass from the edges until men and teams could travel over it. The work is being finished by the use of scrapers and wagons.

CORE WALL—The core wall is built up in 10-ft. levels ahead of the earth work. First the materials are brought upon the work and are distributed along a strip of the dam about 20 ft. wide next to the wall. Then the forms are erected, a steam concrete mixer is brought on and a platform is built at intervals of 100 ft. The concrete is pulled up an inclined plane, by horses working on a block and tackle system. Three-wheeled cars are used, holding 1 cu.yd. of concrete, and these are dumped over the edge of the forms into place.

OUTLET TOWER—The circular tower, or valve pit, is erected at the upper end of the outlet tunnel and is made of concrete reinforced with heavy steel bars and rods. The tower is 6 ft. in diameter inside of a 24-in. wall. A system of valves, 28 in number, is being built into this tower spaced vertically and horizontally to give a helical course up from the bottom of the tower and in order that every one can be operated from the top of the structure when this is completed.

The tower is up to the 67-ft. level now, and has been constructed by the use of a trestle work extending from the hillside at the regular 10-ft. levels. At this level the trestle was so high that when the reservoir is filled, each spring, the timber work attempted to float. This work therefore has been taken down and built into a circular barge. The tower will be erected to the yearly 10-ft. levels from this barge while the reservoir is full in the spring. The barge will lower with the surface of the water as the same is drawn out and will rise to the upper level the next spring when another 10-ft. level will be built.

CONSTRUCTION WORK UNDER WAY AT "MAMMOTH RESERVOIR" DAM, PRICE, UTAH

ORGANIZATION, ETC.—This is an example of doing work under difficulties, yet the work does not suffer in consequence. The dam should be of interest as one of the largest earthen dams in the United States, and as it is being built without any modern machinery, except the smallest steam concrete mixer made. A 12-mile dug-way through a precipitous cañon renders the hauling of heavy freight very difficult. The roller was cast in seven sections so that, with the frame, eight loads could be made of it.

The earth fill is costing 38c. per cu.yd., and the concrete $9.87 per cu.yd. The overhead charges are very nominal.

The work is visited annually by the State Engineer and the State Land Board. The report of the State Land Board after a recent visit to this dam went so far as to say that this work was, without question, the best of its kind in the State of Utah.

The New York Rapid Transit Railway Extensions*

By F. Lavis†

III—General Arrangements for Construction

The Operating Contracts

Stated briefly, the original contract‡ for the present subway provided for its construction by the city or with the city's money, its equipment of power stations, electrical apparatus, signals, telephones, rolling stock, etc., being furnished by the operating company, which had a lease for 50 years, with privilege of renewal for 25 more. Contract 2, Brooklyn extension, 35 years and 25 years. These two contracts with the renewals would, therefore, run to 1979 and 1965, respectively. The operating company was to pay a rental sufficient to cover the interest and amortization on the bonds issued by the city in payment of the cost of construction. At the end of the lease, the city to own the structure free and clear, with the right to purchase the equipment.

The elevated lines in Manhattan have a perpetual franchise, so that under the new arrangement, the lease for the extensions to these lines and the third tracks was made to run for 85 years, and is not included in the agreement covering the other lines, which is as follows:

By the terms of the new contracts, the leases of all the *new* lines as well as those of the existing subway are to run for 49 years from Jan. 1, 1917, and provide that the city shall share in the profits of operation, which are to be determined in the following manner:

The revenues of all operated lines of each system will be pooled, the two companies will be allowed to retain all the earnings (after payment of rentals, interest, amortization, etc.) on the lines they now operate, and the city will share in the profits of the rest. The contracts provide for quarterly settlements, which will provide for the following payments:§

1. To the City (in the Interborough contract only) rentals now required to be paid under Contract No. 1 and Contract No. 2, such rentals to continue through the life of the new contract; also (in case of both companies) such rentals actually payable by the company for the use of property in connection with the system, such as are not included in operating expenses.

2. Taxes and governmental charges of every description against each company in connection with the system.

3. All expenses, exclusive of maintenance, actually and necessarily incurred by either lessee in the operation of its system.

4. Twelve per cent. of the quarter's revenue for maintenance, exclusive of depreciation. "Maintenance" shall include repair and replacement of tracks, but not the replacement of any principal part of structure and equipment. If the maintenance cost in any quarter year shall be less than 12 per cent. of the revenue, the unexpended balance shall go into the depreciation funds and if any excess occurs, it may be withdrawn from such funds.

5. (Interborough Contract). For the first year of operation an amount eqaul to 5 per cent. of the revenue for depreciation of such portions as are not repaired or replaced through expenditures for maintenance. Two depreciation funds are established—one for the existing subway, and one for the new lines, and they will be under the control of the Depreciation Fund Board. Depreciation for future years to be agreed upon.

5. (Brooklyn Contract). For the first year of temporary operation an amount equal to 3 per cent. of the year's revenue for depreciation of such portion of roads and equipment as are not repaired or replaced through expenditures for maintenance. This amount for each year will be paid into three depreciation funds—"Depreciation fund for the railroad and equipment," "Depreciation fund for the plant and property of the extensions and additional tracks," and "Depreciation fund for existing railroads." Such funds shall be under the control of the Depreciation Fund Board. Depreciation for future years to be agreed upon.

The Depreciation Fund Board is to consist of three members—one to be chosen by the company, one by the Commission and the third by both jointly, or in case of failure to agree, by the Chief Judge or an Associate Judge of the Court of Appeals, or by the President of the Chamber of Commerce.

6. (Interborough Contract). One-quarter of the sum of $6,335,000 to be retained by the company, as representing the average annual income from the operation of the existing railroads.

6. (Brooklyn Contract). One-quarter of the sum of $3,500,000 to go to the company "as representing the average annual income from the operation of the existing railroads during the two years prior to the beginning of initial operation, out of which the lessee shall pay interest charges on obligations representing the capital investment (preceding the date of this contract) on the existing railroads."

7. One-quarter of an amount equal to 6 per cent. of the company's contribution toward the cost of construction and equipment for initial operation. Out of this payment the company must set aside amounts sufficient, with interest and accretions, to amortize within the terms of the lease such contribution and cost.

8. If additional equipment is provided an amount to be retained by the company equal to one-quarter of the annual interest payable by it upon the cost of such additional equipment: together with a sum equal to ¼ of 1 per cent. for the amortization of such cost.

9. (Interborough Contract). If the company shall share the cost of construction of additions to the Dual System, an amount equal to one-quarter of the annual interest payable by the company upon its share of such cost, together with ¼ of 1 per cent. for amortization.

9. (Brooklyn Contract). To be paid to the city an amount equal to one-quarter of the annual interest payable by the city upon its share of the cost of construction and ⅜ of 1 per cent. of the city's share of such cost.

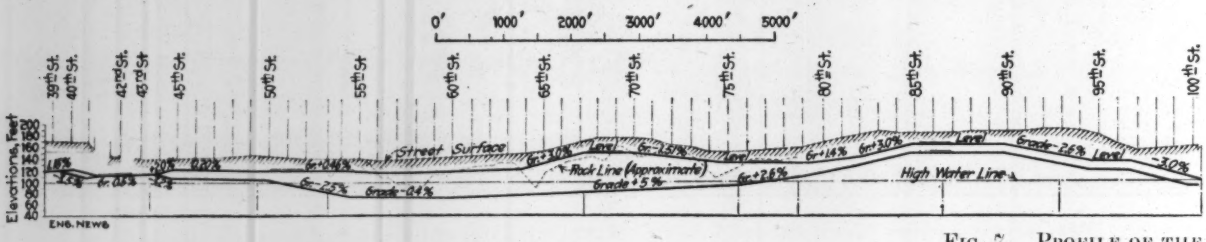


FIG. 7. PROFILE OF THE

*Copyright, 1914, by F. Lavis.

†Consulting Engineer, 50 Church St., New York City.

‡See "Eng. News," Feb. 13, 1902, p. 127, for details.

§From pamphlet issued by the Public Service Commission.

CONTRACT PRICES FOR VARIOUS SECTIONS OF SUBWAY CONSTRUCTION

Location	Route	Section	Contract price Total	Per lin. ft. Structure	Per lin. ft. Track	% completed on Mar. 1, 1914	Contractor
Broadway Line.			$	$	$	%	
Morris to Dey	5	1	1,222,269	607	303	51	F. L. Cranford, Inc.
to Park Place	5	1a	982,741	954	472	31	"
to Walker St	5	2	2,355,829	841	201	82	Degnon Contr. Co.
to Howard	5	2a	912,352	1721	430	56	O'Rourke Constr. Co.
to Bleeker	5	3	2,295,086	879	..	82	Und. & Found'n Co.
to Union Sq	5	4	2,578,078	658	165	20	Dock Contr. Co.
to 26th St	4 & 36	1	2,056,703	....	....	12	E. E. Smith Co.
Varick St.-7th Ave.							
Vesey to Beach	4 & 38	2	3,059,522	940	268	..	Degnon
to Commerce	4 & 38	3	2,185,064	503	126	1	"
to 16th St	4 & 38	4	1,837,927	536	134	..	U. S. Realty Co.
to 30th St	4 & 38	5	2,401,307	673	168	1	U. S. Realty Co.
to 42nd St	4 & 38	6	2,292,944	717	161	..	Rapid Transit Constr. Co.
Lexington Ave.							
53rd to 67th St	5	8	3,369,484	913	215	66	Bradley Contr. Co.
to 79th St	5	9	1,961,997	633	158	79	Patrick McGovern Co.
to 93rd St	5	10	3,253,073	865	134	80	Bradley Contr. Co.
to 106th St	5	11	3,132,195	911	226	83	"
to 118th St	5	12	2,825,740	895	224	86	Oscar Daniels.
to 129th St	5	13	4,071,417	1397	228	60	McMullen, Snare & Triest
to 135th St. (Harlem River)	5	14	3,889,775	1238	361	41	McMullen & Hoff.
to 157th St	5	15	3,820,130	458	183	81	Rogers & Hagerty.
138th to 147th St	19 & 22	1	2,253,282	312	105	12	Richard Carvel Co.
to Bancroft	19 & 22	1a	2,253,159	....	....	..	Rogers & Hagerty.
Completion Steinway Tunnel	50	....	557,857	....	....	2	Degnon
Jerome Ave.							
157th to 182nd St	16	1	1,077,978	81	27	..	Oscar Daniels Co.
to Woodlawn Road	....	2	1,076,831	82	27	..	Cooper & Evans
White Plains Road.							
to Burke Ave	18	1	914,400	71	24	..	Oscar Daniels Co.
to 241st St	....	2	958,480	76	25	..	Alfred P. Roth
Queensborough							
Bridge Plaza	36 & 37	1	884,859	....	....	..	Snare & Triest Co.
Beebe Ave. to Ditmars Ave	....	2	860,744	80	....	97	Cooper & Evans Co.
Van Dam St. to Syracuse Ave	....	3	2,063,588	93* 116†	....	22	E. E. Smith Co.
Brooklyn, 4th Ave.							
Man. Bridge to 43rd St	....	...	16,014,388	....	....	..	6 sections completed.
43rd to 61st St	11b	1	1,930,259	346	91	36	Carpenter & Boxley & Herrick
61st to 89th St	....	2	1,904,171	240	109	28	" " "
New Utrecht Ave.							
39th to Ave. Y	39	2	1,672,190	71	24	..	Post & McCord

*Steel †Reinforced Concrete.

10. (Interborough Contract). An amount to be paid to the city equal to ¼ of 8.76 per cent. of that portion of the cost of construction paid by the city.

11. An amount to be paid to the city equal to one-quarter of the annual interest actually payable by it upon its share of the cost of construction of additional lines, together with ¼ of 1 per cent. for amortization.

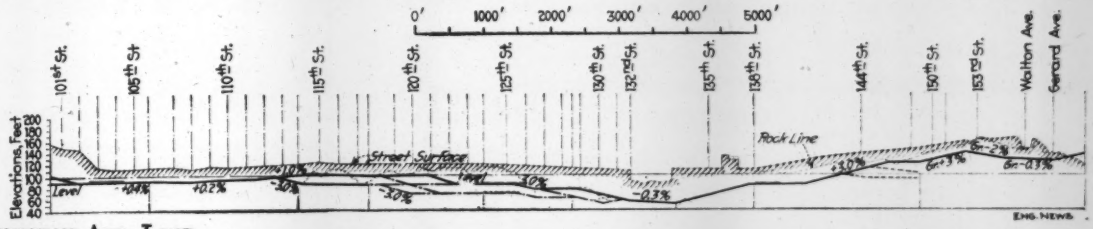
12. One per cent. of the revenue to be paid into a separate fund under control of the Depreciation Fund Board to be invested and reinvested to provide a contingent reserve fund. When such fund equals 1 per cent. of the cost of construction and equipment, payments to it shall be suspended and interest on it shall be included in the revenue. If it falls below 1 per cent., payments shall be resumed until it again equals 1 per cent. This fund shall be used to meet deficits in operation and other purposes.

13. The amount remaining after making the foregoing deductions, shall be divided equally between the city and the company.

Route and Section Numbers

The custom was established in the days of the old Rapid Transit Commission of assigning a number to the various different routes proposed from time to time for new lines, and this has been perpetuated, as, for instance, the Lexington Ave. route is Route 5, etc. It seems hardly necessary, however, for the purpose of these articles to enumerate these in detail.

For construction purposes, each route is divided into sections, numbered consecutively from the beginning and usually from the south toward the north in Manhattan and the Bronx, from west to east in Brooklyn. The sections vary considerably in length, but are generally about half a mile, and the bids so far obtained range from about $800,000 to $4,000,000 per section. The cost of structure and per foot of track is shown in the accompanying table, which also shows the per cent. of work completed on each section on Mar. 1, 1914, and the names of the contractors. The prices given in this table do not include station finish, such as tiling, stairways, ticket offices, railing, etc., or any track or equipment.



LEXINGTON AVE. LINE

There is very little comment which can be made on these figures The work is so varied that there is, as will be seen, a wide variation in the prices either per lin.ft. of track or per lin.ft. of structure. The Lexington Ave. line is perhaps fairly typical of normal conditions. (See profile, Fig. 7.) From 53rd St. to 129th St. the price is fairly uniform at about $225 per lin.ft. of track. Sections 9 and 10, however, have two tracks in tunnel which can be built with little or no interference with subsurface structures and no street

support, and this is reflected in the lower price. Section 13 has a high price per lin.ft. of structure, as this, as will be noted later, provides for a very elaborate system of track crossings. Section 14 is the Harlem River crossing. The sections north of the Harlem, Route 5, Section 15, Routes 19 and 22, Sections 1 and 1a, where only part of the street is required to be decked and where the street cars are operated by the overhead trolley, show a considerable decrease in the cost per lin.ft., as do also the elevated structures on Jerome Ave. and White Plains Road.

On the down-town lines, Route 5 (Broadway), Section 1 involves the support of the elevated railroad structure; Section 1a the two reversed curves driven in tunnel; Section 2a the crossing of Canal St., where the underground conditions are very bad. The other sections, which are perhaps more nearly normal, show approximately an approach to the commonly accepted rough estimate figure of $1,000,000 per mile of track, built in subway.

Equipment

There has been no announcement so far of any change in type of rolling stock of the Interborough, but the B. R. T. has had a larger type of car designed, Fig. 9, providing considerably greater capacity, which will, it is thought, owing to the arrangement of the doors, permit such easy ingress and egress that there will be no more delay in loading and unloading than there is with the small cars now in use. The principal dimensions of these two cars are as follows:

	Interborough	B. R. T.
Length over all, ft.	51.0	67
Width over all, ft.	9.5	10
Weight of empty car on each axle of motor truck, lb.	30,800	(a)
Weight of the other two axles, lb.	22,200	(a)
Number of seats	48	78
Capacity, sitting and standing	175	270

(a) Not to exceed 31,000 lb. per axle when fully loaded.

There have been many difficulties to overcome in connection with the design of these larger cars. Axle loads of 31,000 lb. cannot be exceeded, as this is fixed by the bridge department for the East River bridges. The motors are arranged one on each truck, instead of both on one truck, as on the present Interborough car, this, of course, giving a better distribution of the weight and taking care of some of the increase in the weight of the body and number of passengers. The limitation as to the axle loadings could not be overcome by the adoption of six-wheeled trucks, even though their use were not prohibited by the sharp curvature, as this would only involve a heavier truck with practically the same concentration of load so far as the bridge structures are concerned.

Some important improvements are to be introduced in the equipment of the cars. The combined car and air-line couplers (described in Engineering News, Feb. 29, 1912) have proven very satisfactory, and in addition to these couplers a device is to be installed in the new equipment which will also permit the automatic coupling of the electrical connections (10 in all). The coupling and uncoupling will be entirely under the control of the motorman in the cab and be governed by an interlocking device so that the electrical connection cannot be made until the air-line coupling is complete and the brakes are under control. Similarly to uncouple, the release of the electrical connection by the motorman permits him to release the devices so that the air and train couplings will part. It is hoped by these devices to materially decrease the number of accidents to men uncoupling cars, and also to reduce the time and expense of making up trains.

Before the introduction of this automatic coupler the link-and-pin type had been in general use, but even with eight-car trains on the Interborough, the breaking in

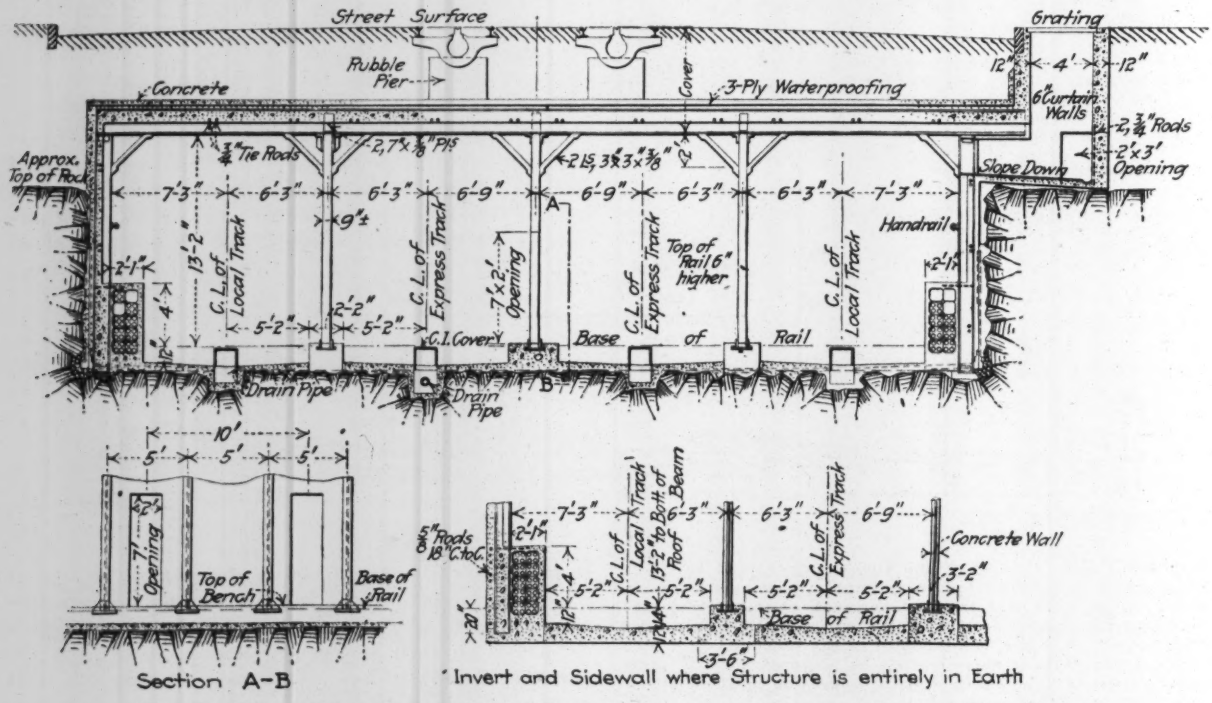


Fig. 8. Typical Section of Rapid Transit Subway on Seventh Ave. at 23rd St.

two of the trains was frequent enough to show that the limit had been reached for this type of couplings. Automatic stops in connection with the signals are in use in the present subway, and the sudden setting of the brakes produces heavy stresses on the couplings. The new coupler has satisfactorily stood all the strains due to these causes, and the introduction of 10-car trains made it almost an absolute necessity. Electric pneumatic brake control will be used on the new equipment, insuring more nearly simultaneous action of the brakes on all the cars.

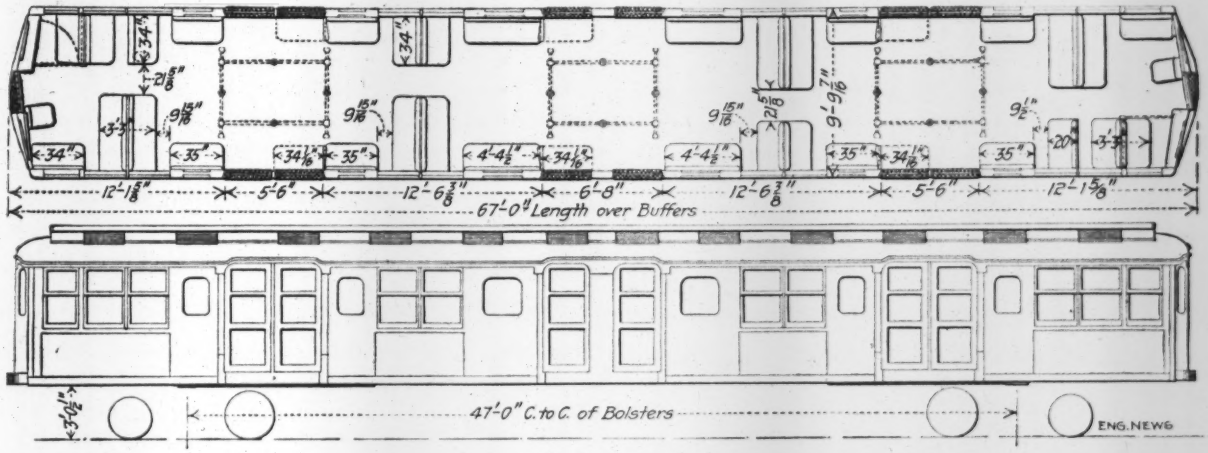


FIG. 9. DESIGN FOR STEEL CAR; BROOKLYN RAPID TRANSIT SYSTEM

The signal to the motorman is given by the closing of an electric circuit when all the doors of the train are closed. This has been in use successfully for some little time already, and not only saves the delay due to transmitting the signal from car to car by hand, but also acts as a safety device in preventing the starting of the train while any door is open.

A species of weighing device has been introduced in connection with the air-brake system to maintain the same ratio of braking power on loaded and empty cars. As the car is stopped at the station, the variation in the load due to the discharge or receipt of passengers, actuates a piston in an auxiliary air cylinder, directly connected to the jam-cylinder. The variation in the position of this piston in the auxiliary cylinder regulates the volume of the jam cylinder, thereby regulating the effective pressure obtained from a given amount of air; thus when the car is fully loaded the volume of the auxiliary cylinder is at its minimum, and when the car is empty it is at its maximum. When the doors are closed it is automatically locked in this position until they are opened at the next station, thus preventing any change from variations in the loading due to the vibration and oscillation of the moving train.

A similar device is to be applied to the accelerating system. At present this has to be adjusted so that it will not slip the wheels of an unloaded car. With the proposed device, however, it will be so adjusted that it will be increased under load.

By these various devices it is expected to save six minutes in time between 59th St. and Coney Island. Deceleration from 50 miles per hour will be accomplished at the rate of 3 mi. per hr. per sec. (on the emergency) as compared with the present maximum of 2 mi. per hr. per sec., and from the lower rates of speed at higher rates of deceleration, while acceleration will be at the rate of 1½ mi. per hr. per sec.

Comparison of this with some comparatively recent practice on electrified steam railroads is of interest.

N. Y., N. H. & H. R.R.—Multiple unit trains 1 motor 2 trailers acceleration 0.5 mi. per hr. per sec. Schedule speed from Grand Central Station to Mt. Vernon, 13½ miles, with 1 stop in 28 minutes.

Lancashire & Yorkshire R.R., England—Acceleration to 30 mi. per hr. in 30 sec. Schedule speed, 18½ miles with 14 stops in 37 minutes.

POWER

Power for the Interborough system is to be furnished from the power houses at 59th St. and the North River and at 74th St. and the East River. The former, built to furnish power for the present subway, was originally equipped with nine reciprocating units with a total normal capacity of 7500 kw. each. This was increased later by the addition of five low-pressure turbines each having an additional capacity of 7500 kw. and using exhaust steam from the original units to a total of 105,000 kw. This plant is now to be enlarged by the addition of two 30,000-kw. turbine units, each unit consisting of a high-pressure high-speed set exhausting into a low-pressure low-speed turbine, making the total normal capacity about 165,000 kw.

The 74th St. power house was built only 13 years ago when the elevated lines were electrified, but owing to the rapid change and improvement which is continually taking place in electrical machinery and apparatus, part of this plant is to be replaced. The old equipment consisted of eight units (reciprocating) and one turbine unit of 7500 kw. each. Four of these are to be taken out and three turbine generators of 30,000 kw. each are to be installed, which, with the five old units remaining, will make a total normal capacity of 127,500 kw.

The contracts between the operating companies and the city call for an average speed on express tracks between main-line terminals of 25 miles per hour, including stops of 30 seconds at each intermediate station, and an average speed on local tracks between terminals of 15 miles per hour, including stops of 20 seconds at each intermediate station.

Gradients and Alignment

Unlike the location of steam railroads, the location of such lines as these under consideration is governed only to a comparatively small extent by questions of gradient or alignment as they affect economy of operation. The primary consideration, of course, is the general location of the lines through or under streets in those sections of the city where the service is needed. The second consideration is, the location of the various stations, which, in the lower part of Manhattan (below 42d St.) are about five or six blocks (1200 to 1500 ft.), and in the outlying sections about 2500 ft. apart, and which is generally arbitrarily fixed by local conditions. Then the grades and alignment (within certain fairly wide limits) are made to fit these conditions. At present, owing to the fact that some sections of the line are not definitely designed, it is not possible to make an exact and complete statement covering the gradients and alignments of the whole system, but the following is approximately correct.

Gradients—Gradients up to 3% may be considered normal, this upper limit being used with considerable frequency, though generally in comparatively short stretches. Some of the longest are nearly 1500 ft. in length, and in a very few cases 3% grades, as long as this occur as ascending grades immediately beyond a station stop on the local lines. There are gradients in excess of this up to 4.5%, and in one case where the Centre St. loop connects to the old Brooklyn Bridge it has been necessary to use 5.4%. The higher rates of gradient occur mostly in connection with the approaches to the East River Bridges or the tunnels under the rivers, the grades on the former being 3.4% on the three newer bridges and 3.75% on the old Brooklyn Bridge.

With electrical operation and especially with the dense traffic conditions which exist or which will exist on the Rapid Transit lines in New York, the question of gradients is not so important as it is in connection with the locations of railroad lines for operation by steam locomotives, or where continuous sustained effort is required on long supported gradients.

For short sections of heavy grade, extra power is supplied through an additional feed wire, or wires to the points where it is needed. The electric motor as is known can stand a heavy overload of as much as 100%, or even more for short periods, the amount of the load and the time which it can be carried being limited by the heating which takes place under these conditions. Short stretches of steep gradient are not, therefore, limiting or as important as longer ones would be. Considering the requirements for some reserve power for ordinary operation which have to be fairly liberal, on account of the great seriousness of any delay as well as the short distance between stations, it can be seen that the limits controlling the gradients which may be used are rather wide.

In the operation of self-contained motor cars also, there is the advantage over trains hauled by locomotives that all additional load increases the adhesion and, therefore, permits application of the power necessary to haul it. It may also be noted that the new motors are to be artificially cooled by blowers.

The general procedure has been that the gradients are fixed by local conditions within the limits given above, then the motors are designed to carry the load. Momentum is availed of wherever possible, where under normal conditions trains may be expected to utilize it in overcoming ascending gradients, and this can be quite safely done, because in case a train is stopped on an up grade, the motors can be relied to start it and move it along, even though at low speed, on account of their great capacity for overload. The original subway equipment was designed on a basis of about 60% motors and 40% trailers, but the tendency is toward the equipment of all cars with motors.

On the underground lines so far as possible, stations have been located at summits of gradients, both in order to get them as near the surface as possible and also that the ascending gradient may be utilized in braking, and the descending grade to help acceleration. While, however, these two purposes mutually help each other on the subway lines, and the rise and fall involved is, therefore, not an operating expense, this is not the case on the elevated lines. These latter, of course, must maintain a certain minimum elevation over summits, but the comparatively slight additional cost of longer columns is so little, that there is every inducement to avoid dipping down into depressions even, or perhaps especially, if stations happen to be located at such points, and it has seemed better to put in escalators or elevators than to drop the track grade down, involving braking on a descending grade and acceleration against an opposing grade.

In one instance at least, on the original subway (at 33d St. and Park Ave.) on the four-track section, the two center tracks, which are used for the expresses, are carried through on an even grade, while the outer two local tracks are raised up at the station. On the new lines the tracks generally all follow the same grade except on Lexington Ave., where the express tracks are located on a lower grade in tunnel through the hill; but here, on account of the necessity of having an express stop at some point as nearly as possible midway between 42d St. and 125th St., it was necessary to bring the express tracks up near the surface at 86th St., as shown in the profile, Fig. 7, which is very typical of the way local conditions absolutely control the profile. From an operating standpoint, of course, it would have been much better to have run all the way through the hill on the lower grade.

On account of the capacity of the electric motor for overload also, there is little necessity for, or benefit to be derived from, the compensation of grades for curvature, although it is not uncommon to find the heavier rates of gradient combined with quite sharp curvature, as for instance, at Vesey St. and Broadway, where there is a 4% grade on a curve of 200 ft. radius.

By reference to the profile of the original subway line (Eng. News, Feb. 20, 1902) it will be seen that much steeper gradients have been found necessary on the new routes than are used on the present line, but this, as is explained above, has virtually been forced by the conditions which have had to be met, which are more onerous in many cases on the new routes than on the old.

On the old line, the Broadway section has no gradient in excess of 1.5%, and the Bronx branch has 3% grades only at the crossing of the Harlem River and 2.2% just beyond where the line comes out on to the elevated structure.

In a way the profile given, Fig. 7, of the Lexington Ave. line from 40th St. to 138th St. may be considered fairly typical, though on the other hand, the Varick St.-Seventh Ave. line from the Battery to 42d St. has light grades

throughout its length, comparing favorably with the old line, with which it will connect at 42d St.

ALIGNMENT—The alignment, of course, is governed by the same considerations of the necessity of following the streets, and so far as possible, avoiding encroachment on private property. This is especially difficult in the lower part of Manhattan where the streets are narrow and crooked, and where it is especially difficult to turn the curves, so that in some instances, notably at St. Paul's Churchyard, at Vesey St. and Broadway, and also at 42d St. and Lexington Ave., it has been necessary to acquire easements under private property at considerable expense. On the new lines all stations are to be located on tangents, to avoid the difficulties found on the original subways with stations on curves.

On the present subway in which cars 51 ft. long and 9 ft. 0½ in. wide are operated, there are the following sharp curves:

	Ft. rad.
City Hall loop	147¼
Forty-second St. and Park Ave	180
South Ferry loop	191
Main express tracks	225

The outer rails on curves were elevated for speeds of 30 mi. per hr. with a maximum of 6½ in., and this practice is followed in designing the new lines, though in some cases the operating company has increased the elevation in the old subway to permit speeds of 40 mi. per hr., on some of the curves of large radius.

On the new lines 500 ft. has been considered the minimum radius for ordinary cases, 200 ft. the absolute minimum, except that there is one curve of 150 ft. radius. On the B. R. T. lines additional clearance has to be provided on curves to provide for the extra overhang of the larger cars, 67 ft. long and 10 ft. wide, which that company proposes to use.

Transition curves of a uniform length of 150 ft., irrespective of the degree of curvature are used, wherever it is possible to get them in. Crandall's formulas and tables are used. It may be noted that curves are usually laid out with radii of even feet instead of with even degrees of curvature.

CONTRACTS AND SPECIFICATIONS

GENERAL CLAUSES—The clauses of the specifications indicating the character of the work to be performed under each item or type of construction, will be discussed or quoted under each separate heading, together with the descriptions of the work. The general clauses of the contract and specifications where they differ from ordinary practice, or where they have particular applications on this work are briefly noted below.

The contracts are printed in pamphlet form, letter-size sheet (8x11). There is a table of contents at the beginning and a complete index at the end. Plans were published originally on large sheets about 22x30, lithographed and bound together, but this has been changed for smaller-sized plans which are lithographed on thin paper uniformly 11 in. wide, and bound into letter size (8x11) pamphlets the same as the contracts, thus making them very easy and convenient to handle.

The contracts for the general construction do not include any station finish of any kind, nor the track, ballast, or electrical equipment except such parts as necessarily have to be incorporated in the main structure, such as conduits for electric wiring, power cables, etc., and the ducts or pipes for lighting wires at the stations. The automatic pumps at the pumping stations are included as, of course, the drainage has to be taken care of from the beginning. The contract drawings usually include enough plans showing the general scheme of station finish, so that the contractor may have this as a guide in carrying out his work and that he may make due allowances for it. All necessary changes in location of sewers, water and gas pipes, electrical conduits, etc., required by the construction of the subway are included in the contract, the principal changes of the larger structures are shown on the plans, but exact details of smaller pipes, conduits, etc., are left until the existing pipes are uncovered, and all subsurface structures definitely and exactly located.

Approximate quantities of each item are given for the purpose of comparing the bids on a basis of total cost. The time may be extended or diminished if there is any material change in total quantities.

There are provisions calling special attention to the necessity of compliance with state and city laws, especially the eight-hour law and the requirement that contractors shall pay the union scale of wages.

As the work is to a large extent to be carried out in residential districts, there are provisions which give the engineers adequate control of night work of any kind which might disturb people living near the line. Blasting is not permitted between the hours of 11 p.m. and 7 a.m. There are strict provisions (regular city ordinance) for the storage of explosives, the maximum capacity in any magazine being 250 lb., and in most of them not over 100 lb.

BOND—A certified check for a stated sum, varying from $10,000 to $25,000, according to the size of the contract, is required with all proposals and a bond of a stated sum of approximately 10% of the amount of the contract from the accepted contractor, 15% is retained from the monthly payments up to a total of about 10% of the amount of the contract, after which only 10% is deducted.

TIME—The following clause is of interest in the provision for completion within the specified time:

> In the event of delay . . . . . the city . . . . . shall be paid damages for such delay. Inasmuch as the amount of such damages will be extremely difficult to ascertain, especially in view of the fact that the railroad herein contracted for is only a part of a complete system, the remainder of which is to be constructed under other contracts, it is hereby expressly agreed that damages shall be liquidated and paid by reducing the price to be paid the contractor as follows:

The provision then is for the retention of 1% of the amount due for the work done in the first month, after the time elapses, 2% for the second month, and so on.

The following "blanket" clause is of interest in connection with works of large magnitude, where the subsurface conditions are as uncertain as they may be in a city:

> The specifications and contract drawings hereinafter mentioned and taken in connection with the other provisions of this contract, are intended by the Commission to be full and comprehensive, and to show all the work required to be done. But in a work of this magnitude it is impossible either in advance to show all details, or precisely to forecast all exigencies. The specifications and contract drawings are to be taken, therefore, as indicating the amount of work, its nature and the method of construction so far as the same are now distinctly apprehended. The railroad is intended to be constructed for actual use and operation as an intraurban railroad of the highest class, adapted to the necessities of the people of New York, in the best manner, according to the best rules and usages of railroad construction, and in the event of any doubt as to the meaning of any portion or portions of the specifications or contract drawings, or of the

text of the contract, the same shall be interpreted as calling for the best construction, both as to materials and workmanship, capable of being supplied or applied under the then existing local conditions. All the clauses of the specifications, and all the parts of the contract drawings are, therefore, to be understood, construed and interpreted as intending to produce the results hereinbefore stated.

MONTHLY ESTIMATES—The engineer shall make an estimate of the amount and value of the work done as in his opinion shall be just and fair, but shall not necessarily be governed by the unit prices contained in the contractors' proposal, and provided that such estimate shall be withheld or reduced if in the opinion of the engineer the work is not proceeding in accordance with the contract.

An allowance is made for structural steel delivered, at the rate of $40 per ton.

The contracts provide that the city shall make payments on estimates within 30 days after a certificate is issued by the commission. As a matter of fact, payments are usually made within 30 days of the end of the month covered by each estimate. Final payments are to be made 90 days after the filing of a certificate of completion.

SHAFTS AND OPENINGS—Plans showing the location of all shafts, plant to be erected in the streets, supports of street decking, openings in decking, etc., must be submitted to the engineers, and receive their approval before work is commenced. This, of course, in addition to the regular permits to be obtained from the city.

LIABILITY—The contractor admits (under the form of contract) that if the work be done without fault or negligence on his part that the plans, etc., do not involve any danger of foundations, walls, or other parts of adjacent buildings, etc.

Soldiers of Peace

BY LESTER C. GUSTIN*

Northward across the "Circle"
Where the stalking snowstorms creep,
Westward across the desert
Where the burning sandstorms sweep,
Southward amid the fevers
Where tropic death-shafts light,
The Soldiers of Peace are fighting
Their never ending fight.

Not in the swirl of conflict
'Mid crash of the smoking guns,
On the crest of a wild charge surging
Their toil-worn pathway runs—
But slowly with tape and transit,
With shovel and pick and steel—
Till the wondering jungles echo
To the hum of the spinning wheel.

On the shores of the Northland oceans
Where the stinging sleet claws grip,
Their sea-walls mock the ice packs
That harry the battered ship,
And the whining storm wind mutters
As the sheeted hulk tears free,
Safe to a man-built harbor
Wrest' from an angry sea!

Through the burning land of dead things
Where the demon Sun God rules,
Their coughing pack trains stagger
Bringing supplies and tools
To detachments of dauntless workers,
Who laugh at the heat and thirst—
Till the shimmering steel tracks conquer
The land that God had cursed.

In the heart of the sunny Southland
Where the sultry breezes sigh,
The song of their panting dredgers
Flings echoes against the sky,
And the lazy water gurgles
As it chafes at its earthen chains,
As the levee walls rise firmer,
A guard for the sheltered plains.

Through the everlasting mountains
Their pounding rock drills bite,
And the yawning tunnels open
To the smash of their dynamite,
Or a water pathway lengthens
O'er the back of a great divide,
Where their huge locks lift the liners
Up the frowning mountain side!

On the floors of the rushing waters
Through the mud and the silt they go,
Sinking their steel-shod caissons
To the yieldless rock below,
Digging down through the darkness,
Fighting the flood with air—
Till the bridge piers breast the torrent
And carry a pathway there!

When the flickering shadows lengthen,
And the glowing embers pale,
Their toil-scarred veterans gather
On many a lonesome trail,
Snatching a moment's freedom,
Ere break of another dawn,
With a thought of the deeds of tomorrow,
A sigh for their comrades gone.

On the stretches of far Alaska,
On isles of the restless deep,
On the prairies of Central China,
Their unknown heroes sleep,
Where the Congo seeks the ocean,
By the Orinoco's head,
'Neath the skies of a hundred nations,
Slumber their nameless dead.

By a boiler's wild explosion,
By the redskin's feathered dart,
'Mid the chaos of twisted girders
When the great bridge trusses part,
By the burn of the wasting fever,
With a smile as the pale lips blue,
A curse that their work is finished,
A prayer that the job goes through!

By the creak of their straining derricks,
By the drum of their hammered steel,
By their walls on the storm-lashed ocean,
Where their rock-ribbed watch dogs peal,
By the stretch of their water ditches,
By their rails through the trackless wood,
Ye shall know their work when ye see it
And know that their work is good!

Eastward across the surges
Where the Old-World nations lie,
Westward admidst the mountains
That shoulder aside the sky,
Hereward among the cities
In the sickly arc-glow light,
The Soldiers of Peace are fighting
Their never ending fight.

Their's not the victor's laurel
When a hard fought field is won,
No cheers of a grateful people
But pride in a task well done;
No blare of the conqueror's trumpet,
No garlands of flowers cast
But the sight of a work well builded,
And a faith that that work will last!

*Civil Engineer, 23 Dartmouth St., Somerville, Mass.

A Dry-Pipe Sprinkler Installation on the new State Pier at Providence, R. I., consists of four dry-pipe sprinkler systems with 1125 heads. On account of the prevailing low winter temperature, a special hot water system keeps the water leading to the dry-pipe valves above freezing. The installation was made by the General Fire Extinguisher Co.

Editorials

Opportunities for Engineers

Those of our readers who find themselves open for professional engagements on account of the war and its backfire in American financial circles, might move to Detroit. If their experience has been along mechanical lines, with an effective disguise in speech and appearance, they should be able to get from $5 a day up as a cog in the Ford machine. If, on the other hand, their training has been structural, a few weeks' study and labor should make them eligible for membership in the local bricklayers' union and then their fortunes would be made. Just now ordinary bricklayers in Detroit are being paid $1 per hour and on one sewer job—a good clear free-air 10-ft. tunnel—bricklayers are drawing $10 per shift, which rarely exceeds 8 hours and is sometimes much less.

Safety First at the Elevator Door

In our last issue we commented on the excellent work being done in the promotion of general public safety by the American Society of Mechanical Engineers through its efforts to draw up standard specifications for the construction and operation of steam boilers and to formulate a model state boiler law. It seems worth while to point out another field where concerted action by some equally disinterested association would be productive of almost as great public benefit. We suggest that provision for increased safety in the construction and operation of elevators be similarly studied—though not necessarily by this same society, for there may be others in even better positions to take up such a work.

Our attention is repeatedly called to the needs in this field by various insurance bulletins on industrial accidents, where the comparatively large number of elevator accidents are noteworthy. For instance, a statement before us of the Fidelity & Casualty Co., gives statistics of individual accidents during July, 1914. There were 66 elevator accidents during the month, but only 16 boiler explosions and 5 flywheel mishaps. Thirteen falling elevators caused the death of 3 persons and the injury of 31; 12 people were killed by falling down elevator shafts and 12 were injured; there were 31 accidents in which 9 persons were crushed to death and 22 were injured by moving elevators.

Study of such figures confirms the opinion that a comparatively high degree of protection has been secured against serious accidents due to the fall of elevators, since the number of cases is small and the casualties not severe. The figures do show, however, that great risks still prevail at elevator-shaft doors and elevator gates. In a year, upward of 200 people are killed at these danger points and upward of 300 are injured. Any engineer who has attentively observed elevator operation in New York City, which offers a good chance of intensive experience, must have been impressed with innumerable cases of unlatched and unguarded shaft doors and failures to provide or use safety gates on the car openings. Here then seems to be an important field for the "Safety-First" enthusiasts.

A Chance for Economy in Public-Utility Service

Why should gas-, electricity- and water-supply and even telephone-service companies continue to send out bills every month, or twelve times a year, when quarterly meter reading and billing, or only four times a year, would save from 25 to 40% of the amounts of the smallest bills rendered and from 10 to 15% of the annual cost of serving a very considerable proportion of its patrons? This question is naturally raised by the letter published elsewhere in this issue, criticizing the Cleveland Municipal electric plant and our recent analysis of its probable operating results. The writer of the letter calls attention to the small consumers who do not use enough current at times to make their bill equal the minimum charge imposed, and argues that they do not really have the advantage of the low rate advertised. This effect has been incidentally noted by commissions and courts, and in one case the Ohio Supreme Court held that minimum charges were illegal because they brought unit prices to small consumers above the limit fixed by franchise.

That such a large saving as we have noted above is possible on much of the business of gas, water and electric companies may be shown by a few figures. In 1909, the Massachusetts Board of Gas & Electric Light Commissioners inquired into the minimum monthly charges of the Boston Edison Co., and the company submitted the following as its actual cost per month of supplying each consumer paying the minimum rate:

Meter interest and depreciation	$0.232
Testing and repair	0.064
Meter reading	0.035
Accounting, billing, postage and stationery	0.245
Energy supplied (4.5 kw.-hr. at 3c.)	0.135
	$0.711

In 1912, the New Jersey Public Service Commission inquired into the monthly minimum rates of the Public Service Corporation and made up from the books of the company the following table of monthly costs per customer:

Meter and connection interest and depreciation	$0.295
Meter and connection maintenance	0.112
Distribution expense	0.090
Indexing meters	0.023
Office salaries and expenses	0.225
Expense coHection	0.055
Expense	0.065
Energy loss in transformers	0.090
Energy supplied (6 kw.-hr. at 3c.)	0.180
	$1,135

In both tables the last item has been added from data accompanying the tabulation and assuming a total cost of energy alone at the customer's premises of 3c.

In the case of the Boston company 28c., and in the case of the New Jersey company 37c. represents the actual cost per month of meter reading, billing, etc. These items could be reduced to one-third this amount by reading the meters and rendering the bills quarterly instead of

monthly. The total annual saving per customer in these cases would range from $2.25 to $3. Besides this saving to the company, there would be an additional saving to the customers in postage and time in paying bills, which would add a considerable amount to this total.

It is argued that the companies must make monthly collections to meet their current expenses. But labor is the one important item which is really paid for in cash. Fuel and other supplies going into operation and maintenance are generally purchased on credit, running as high as 90 days. It would seem quite fair if the payments from the customers could justly be made in conformity with the payments which the company has to make—semi-annually in the case of interest and up to quarterly on supplies, especially if rate-basis values carry a certain amount of working capital to cover payments between quarterly collections.

By cutting down the cost of collection, the minimum charges and effective unit prices can be lowered to attract the small customers who are desirable additions if they pay their cost, since they increase the diversity of load and the popularity of service. It is a matter of recorded experience that the generating capacity needed to carry the small electric-light customers' load may be only about a third that indicated by the sum of their maximum demands and a fifth that shown by their installed fixtures.

It cannot be said that reading meters and rendering bills quarterly instead of monthly is impracticable, nor that it would impair the business of the companies, since many prosperous water companies follow this plan and have always followed it.

There is, however, a large opportunity for saving in the water-works field also, for we have been surprised to find that even here a considerable number of the works are incurring the expense of rendering monthly bills. A committee of the American Water-Works Association, which compiled data on American water-works rates and service, secured information on 437 plants out of the 6000 odd probably in existence. The committee's tables show that of 276 of these works operating on a meter basis, 111 render accounts for the most part quarterly and 165 monthly. The figures for the quarterly and monthly arrangements, respectively, are proportioned 43 and 47 for the New England and North Atlantic States; 52 and 51 for the Central and Middle West; 3 and 29 for the Far West; 13 and 38 for the Southern and South Atlantic. Probably in a majority of the remaining water-works, which are the smaller ones of the country and in which presumably meters are the exception rather than the rule, the payment takes the form of an annual assessment or "tax," so that the actual proportion of monthly bills to quarterly or less frequent ones for the whole water-works industry is insignificant.

The Prospects for South American Trade

The number of engineers and business men who on account of the current stagnation of industry in the United States are looking for openings in South America is so great that the article by Cyrus Townsend Brady, Jr., published elsewhere in this issue, is particularly timely. Mr. Brady writes with an intimate knowledge of South American conditions and his statements are corroborated also by other well known engineers who have had experience there.

It is to be borne in mind, however, that Mr. Brady writes of South America as he has known it during the past dozen years, while during the past two months the most revolutionary change that history records has swept over the financial and industrial world. The question what effect this change is to have on the commercial relations of the United States with South America is an exceedingly difficult one.

Broadly speaking, South America imports all its manufactured goods. In 1913, its total imports were valued at $1,304,000,000, of which $317,000,000 came from the United States. The exports of France, Germany and Belgium to South America were valued at $368,000,000, and Great Britain's, $322,000,000. The great bulk of the exports from France, Germany and Belgium are now cut off and if South America were to continue to purchase at the same rate as in 1913 it would probably tax the surplus capacity of the factories in both England and the United States to supply the demand.

At present, however, all accounts agree that the European war and its accompanying financial stringency has paralyzed commerce and industry in South America. Business conditions appear to be worse there even than in the countries of Europe outside the immediate zone of military operations.

South America has long been accustomed to do business on very long credit. It is claimed that one of the methods by which Germany has secured so large a portion of South American trade is by the coöperation of the German banks and trading companies with German manufacturers, so that orders have been secured in competition with manufacturers of other nations largely on the basis of the long period of credit extended. Very few American manufacturers are willing to do business under such conditions, nor are their banking facilities such as would permit them to do so.

Traders in South America, while they would be glad to purchase American goods when their supply from Europe is cut off, have not the money to pay for the goods and have, moreover, no way of obtaining the money. They can no longer borrow from their European connections, and, worst of all, the exports of raw materials to Europe, on which in the end South America relies to finance its imports of manufactured goods, have been cut down to very small proportions by the paralysis of European industry. The whole situation furnishes in fact an object lesson of the economic truth that international trade after all rests on the basis finally of barter. The transfer of gold is only a means of settling trade balances. In the long run a country can only import large quantities of manufactured goods by sending abroad a volume of exports of substantially equal value.

That was a most interesting incident in international trade that occurred last month when a vessel arrived in the port of New York from Iceland, commissioned by the government of Iceland to purchase wheat and other foodstuffs required by the inhabitants of that far northern land for their winter consumption and bringing to pay for them not gold coin or bullion, or drafts on European bankers for gold, but a shipload of fine wool, dried fish and other marketable products of the far north.

In order to increase our export trade to South America, therefore, the first step will be to increase our imports of South American products, the European market for which has failed. This can be done to some extent without doubt; but we are already South America's largest customer, buying over $500,000,000 worth from her last year. But South America exports to other countries over a billion dollars worth per annum. Any increase in our purchases would be only a drop in the bucket compared with the vast amount that Europe normally draws from South America.

Much of the South American export trade to Europe, however, must be soon reëstablished. The meat and grain of Argentine are essential to Europe's food supply; the nitrates of Chile are essential to maintain the production of European farms. It is equally true, however, that with the resumption of South America's export trade to Europe will come the reëstablishment in large part of the supply of European manufactured goods. British manufacturers are eager to recapture the world's markets which they have lost under stress of German competition.

At present, on account of the enormous number of men withdrawn from active production for military service, industry is stagnant in all European countries, except in industries directly connected with the supply of articles for military use. This worldwide paralysis of trade and industry cannot long continue. While the destruction of capital and the consequent financial stringency the world over resulting from the war are indeed of prime importance, it is to be remembered that the area over which actual military operations have extended is after all of trifling extent. Were hostilities to cease tomorrow, practically all of Europe's factories would be ready for operation for the world's supply of goods. The shortage of capital and of employees will have a certain effect it is true; but there is a large surplus population available to draw upon, the lines of trade are already established, and with the absolute necessity of the export trade to prosperity, it may well be believed that Germany will again be a strong competitor in the export trade not long after peace is declared.

While, therefore, the European war does unquestionably offer certain opportunities never before presented to American manufacturers and exporters, the business will have to be conducted with intelligence of a high order in order to win and hold the customers.

It must be said with great regret that the immediate opportunities for employment in South America of engineers who seek employment solely and have to live on their salaries are anything but encouraging. In fact, while steamers are taking from the United States to South America certain hustling manufacturers' agents and fortune seekers, returning steamers are bringing back to the United States engineers and skilled workmen who were engaged on South American enterprises a few months ago and were thrown out of their positions by the suspension of all industry when the war broke out.

It has been often and truly said that South America is a land of enormously valuable natural resources. There are without doubt a great number of opportunities for men with capital and brains and a knowledge of the country to build up various lines of profitable industry. The drawback to such ventures is the uncertainties as to governmental stability in the various Spanish-American countries. The losses suffered during the past three or four years by Americans who had money invested in Mexico have been extremely discouraging to those promoting investments in the countries farther south. With the high rates which capital can command in the United States on perfectly safe investments under conditions which are likely to prevail for some time, it must take very dazzling promises of profit to induce American capitalists to venture upon South American enterprises.

The Progress of the Steam Turbine Driven Centrifugal Pumping Engine

The City of Philadelphia was recently awarded a contract for two 20,000,000-gal. steam-turbine driven, geared centrifugal pumps to operate against a total head of 330 ft., under a duty guarantee of 145,000,000 ft.-lb. per thousand pounds of steam. The firm which is to build these machines, the De Laval Steam Turbine Co., Trenton, N. J., has also orders on hand for two 24,000,000-Imperial gal. pumps of similar design for the Toronto water-works, operating against a 268-ft. head, and two 6,500,000-gal. pumps operating against a 273-ft. head, for the water-works of San Antonio, Tex. A half dozen other machines of similar large power and capacity, built by the same company, are already in operation in a number of city water-works. These installations are of much interest, as indicating the strong position which the centrifugal pumping engine has already attained as a competitor of the reciprocating pumping engine. The probabilities seem strong that the centrifugal pump is destined to triumph over the reciprocating pump, just as the steam turbine has triumphed over the reciprocating steam engine and well nigh driven it from the market.

It seems no very long time ago that the centrifugal pump was first developed for use against high heads. At the Paris Exposition of 1900, Sulzer Bros., of Zurich, Switzerland, had a notable exhibit of multi-stage centrifugal pumps designed to operate against heads of several hundred feet. The claims for high efficiency made for these pumps were received at the time with a good deal of skepticism. The centrifugal pump was at that time a well known machine, but it had always been designed by rule of thumb, its use was confined to low heads and it was never expected to give high efficiency. The European designers applied scientific principles to the construction of centrifugal pumps, and revolutionized the machine. Pump builders in the United States promptly followed the lead of the Swiss and German designers, and high-speed high-head centrifugal pumps were shortly attainable in the American market.

It was not, however, until the steam turbine was developed to be a machine of high efficiency as well as high speed that the possibilities of the centrifugal pump began to be realized. Development in the steam-turbine field has been so rapid in the past seven years that it has been difficult to keep pace with it. The steam turbine is a machine demanding high-class workmanship and most careful and scientific design. The early steam turbines were prone to serious trouble from stripping of the blades, and were very apt to be extravagant in steam consumption. The steam turbine of the present day has attained

a very creditable degree of economy, and what is still more important, it retains its original economy in service very much better than does the average reciprocating engine. From the commercial point of view, the centrifugal pump is aided in taking the lead because steam-turbine manufacture has now been reduced to such a system that high-speed machines can be turned out at a cost far below the cost of building a reciprocating engine of the same power. Such high-speed machines are not only peculiarly adated to driving electric generators of low cost, but also to the driving of high-head centrifugal pumps.

The high-duty reciprocating pumping engines of large size may well be called a monumental triumph of mechanical engineering. Its full efficiency is still materially higher than the best that the turbine-driven centrifugal pump can show; but a high-duty reciprocating engine of large power is an enormous machine, which requires a costly foundation and a huge building to house it. The steam-driven centrifugal pump of the same capacity is a machine with hardly a tenth part of the weight and size of its giant competitor. All the progress in mechanical engineering in numerous fields during the past half century has been toward the adoption of high-speed rotary motion and the abandonment of slow-speed reciprocating motion. There seems good reason to believe that the steam turbine will eventually win out over the reciprocating steam engine in the pumping-engine field as it has in so many other fields where the reciprocating engine was formerly the only type of prime mover.

Letters to the Editor

On Engineering Opportunities in South America

Sir—I have just read the letter of Cyrus T. Brady, Jr., published in ENGINEERING NEWS of Sept. 3. For some time I have had in mind the desirability of writing something very similar, but owing to press of other work have put the matter off. The case is stated so well in the letter referred to, that there is little to add to it, but I have had so many letters from engineers and others who think there are great opportunities in South America, that I think it is worth while to ask you to publish this, in confirmation of what Mr. Brady has said.

I do not mean to say there are no opportunities at all, but that they are comparatively few, whether for the professions or for commercial enterprise and require trained and experienced men to take advantage of them. It seems particularly necessary at this time to warn against too much optimism in regard to any great expansion of American trade with South America, which it is entirely improbable will take place, though we may be able to lay the foundations for expansion along certain lines of endeavor, if the situation is properly handled.

F. LAVIS.

New York City, Sept. 16, 1914.

Sir—The two letters of Cyrus T. Brady, Jr., in your issues of Apr. 30 and Sept. 3, are so inequivocably correct in all the statements contained therein that the writer did not feel the necessity of commenting on them, but in view of E. L. Verveer's letter in your issue of Sept. 17, criticizing Mr. Brady, the writer has thought that the testimony of an engineer who lived 15 years in Argentina would be welcome to Mr. Brady and interesting to your readers at large.

Mr. Brady has given a most accurate account of conditions in Argentina and the cost of the various articles he mentions are given undoubtedly in U. S. dollars and cents. The writer never wore a pair of boots—while in Argentina—that cost less than 14 or 16 paper dollars, or about 7 or 8 U. S. dollars, nor a suit of clothes that cost less than 60 paper dollars, or 30 U. S. dollars. The same quality of goods would cost in this country just about half those prices.

It is true that food stuffs raised in the country are not very dear—Mr. Brady didn't say anything to the contrary—but, what sort of a house would Mr. Verveer get in Buenos Aires for, say, $70 U. S. currency per month?

Mr. Verveer seems to have an exaggerated idea of the role the French have played in Argentina. With the exception of a short narrow-gage railway in the north of the province of Santa Fé and the port of Rosario, which, curiously enough, is also in the same province, the writer does not recollect any other big engineering enterprise carried out by the French.

As pointed out by Mr. Brady, most of the engineering enterprises are English, while the Germans have also a good share. The fact of the matter is that Argentina, with true business instinct, always tries to secure the best talent regardless of nationality. And so it happens that when the magnificent port at Bahia Blanca was constructed the job was put in the hands of Signor Luiggi, an Italian engineer of international reputation.

That "so many Argentines have . . . sent their sons to France to study engineering" is far from being the case. If Mr. Verveer goes into statistics he will probably find that there are at Cornell more Argentine students than at any engineering college in France, and that by far the largest number of students go to Britain, Germany and Belgium, in normal times, of course. In the latter country, it may be remarked *en passant,* the University of the unfortunate Louvain granted degrees *pour l'exportation,* that is to say, which were of no use whatever in Belgium itself.

British influence has been infinitely more powerful than that of the French. In spite of the difference in religion, there are several British schools in and around Buenos Aires which are largely attended by the natives. British sports have become all the rage and in the comparatively short time of 20 years Association Football—thanks chiefly to the efforts of A. W. Hutton, Rec-

tor of the English High School—has become a national pastime.

Apart from his ideas as to the cost of living and as to French influence in Argentina, Mr. Verveer is quite correct in his assertions, and any engineer intending to go to that country would do well to read his interesting letter.

M. J. LORENTE.

Stone & Webster Engineering Corporation,
Cambridge, Mass.

The Cleveland Municipal Electric Plant

Sir—I have read, in your issue of July 30, the editorial article on Cleveland's new municipal electric plant. I have much interest and complete sympathy for some of the general observations contained therein on relations between electric central stations and the public which they are supplying. I am disposed to believe, however, that the editorial in question falls into error by comparing a utility having a restricted supply with one supplying, and under obligation to supply, an entire community.

It will be conceded generally that an electric central station which is privileged to limit the scope of its operations and to select its territory and customers can show more favorable results than one which is under obligation to supply an entire community. The Cleveland municipal plant is not embarking on the business of supplying the entire people of Cleveland with electricity. It is undertaking to supply a few people and it is in a position to pick its own territory and its own customers. From all that appears, the problem of the management is not to limit the number of customers whose rates will be less than the assumed average cost of 1.96c. but to prevent an influx of customers who will pay the maximum rate of three cents.

The editorial states (p. 261) that "the new municipal electric plant can serve only a small part of Cleveland's great area and seven hundred thousand population." The maximum station capacity is stated to be 25,000 kw. This plant is compared with a company having 100,000 hp. in station capacity and a "distribution system covering nearly the entire city." It does not appear that the municipal plant will reach any considerable proportion of the consumers in Cleveland who, because of their small lighting loads would be confined to the 3-c. maximum rate. Consequently the 3-c. rate is of little if any advantage to the residence lighting consumer.

Your criticism of private company rates, be it noted, extends not to rates afforded power consumers but to what you would have considered a traditional 10-c. maximum for residence lighting. In a city the size of Cleveland, the actual cost of reading and maintaining the average consumer's meter, of keeping his account and of collecting his bill is probably no less than 50c. per month. At the 3-c. rate it would require a consumption of 16⅔ kw.-hr. per month to pay the consumer's cost alone, not to speak of direct and fixed charges on the current consumed and its distribution. A company supplying the entire city at a maximum rate of 3c. would have thousands of customers whose monthly bills would range between 25 and 30c. and $1 at the outside. The company could better afford to give its service gratis to many of these than attempt to collect the small bills resulting from a reading of meters. As originally announced, the rate schedule for the Cleveland municipal plant contained no minimum charge. If a fair minimum is applied, the maximum actual charge in the case of those for whom the greatest solicitude is shown would greatly exceed 3c. The fact seem to be that the 3-c. maximum rate is a fiction in that its application is to be restricted by limiting the customers to whom service is rendered; some selective device must be employed as admittedly there is not enough capacity for the entire city.

The editorial carries its own refutation in the extracts previously quoted therefrom of its characterization of the Cleveland enterprise as "businesslike municipal competition." It is not competition for a municipality to set up an electric plant to take the cream of the business of a private company. Rather is it a modern form of highway robbery. The average railroad rates in the densely populated trunk-line territory are much lower than average rates in the sparsely settled Western classification territory. British tramways have lower nominal rates of fare than American street railways but the miles of track per unit of population are far less. The duty to serve entire communities is a heavy responsibility resting on central-station companies which must inevitably affect the rate so long as there are material differences in the use made of the facilities by different classes of consumers. Your editorial says: "If, however, a city like Cleveland can supply its citizens with electric current produced at lowest cost from an uptodate plant there is no need of interference by commission or courts." By your own admission the city of Cleveland is attempting to do nothing of the kind. On the contrary, it is imposing a heavy responsibility on all of its citizens for the supposed benefit of a favored few in an enterprise which will redound ultimately to the disadvantage of all through the violation of an economic law that monopoly most advantageously can conduct a business characterized by increasing returns.

As your editorial states, the Cleveland experiment is one of national importance. If it were conducted under laboratory methods, and with supervision not tinged with the suspicion of political motives, one would be obliged to accord it full and complete approbation—but for the fact that it does not attempt to solve the really important problem of furnishing electricity to all of the people of the city, including those residing in outlying and sparsely settled sections as well as those affording the best load conditions. As it is, however, Cleveland's experiment deserves nothing but severe condemnation, for, even if experience demonstrates that this small plant can be operated under ideal conditions at extremely low rates, the world will be no wiser as to the exact cost of caring for the needs of entire communities and Cleveland will be paying in the aggregate more for an inferior divided service than it would be required to pay under conditions of closely regulated monopoly.

WILLIAM D. KERR,
Director, Bureau of Public Service Economics.
17 East 38th St., New York City,
Aug. 29, 1914.

[Opportunity was extended to F. W. Ballard, Commissioner of the Cleveland Division of Light and Heat, to

comment on the foregoing criticisms. This he has done in the following letter.—ED.]

Sir: I have read with much interest the letter of the Director of the Bureau of Public Service Economics of New York City in reply to your editorial on the Cleveland Municipal Electric Plant.

It is quite evident that he is not well informed in regard to the conditions in Cleveland, particularly as to the amount of territory which is being served by the municipal light plants. He draws some very odious comparisons tending to show the small and restricted area which is to be furnished by the new municipal plant as compared with the territory which is furnished by the privately owned plant in Cleveland. As a matter of fact, the amount of territory covered by the distribution system of the municipal plants is very much greater than that furnished by the privately owned plant, when considering the relative size of the stations. The small Brooklyn station, which has been in operation for about ten years, and which has only a capacity of 150 kw., or ½% of the capacity of the large privately owned station, has a distribution system covering some ten square miles of territory. Instead of being the "cream" of the business, this territory is almost entirely the residence sections of the city, and largely consists of the suburbs. The privately owned company's distribution system covers the business part of the city, and has all the large customers, and in reality has had the "cream" of the business, or in other words, that part of the business which really pays the most profit. This small plant is the one which secured the good results set forth by the figures in the editorial of the ENGINEERING NEWS referred to.

Also I note that in Mr. Kerr's letter he states that the rate schedule for the Cleveland Municipal Plant contains no minimum charge. He seems to be misinformed on this point, as there is a minimum charge of $.50 for each customer, intended to cover the cost of billing and collecting.

As all the arguments set forth in his letter are based upon these two assumptions, which are entirely erroneous, very few will agree with him in his conclusion that "Cleveland's experiment deserves nothing but severe condemnation."

F. W. BALLARD, Commissioner and Chief Engineer,
Division of Light & Heat.

Cleveland, Ohio, Sept. 26, 1914.

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A New Harbor Map of Philadelphia has been prepared by the Department of Wharves, Docks and Ferries, and is now ready for distribution. It is 32x52 in., and shows the Delaware River, and the navigable portion of the Schuylkill, within the city limits with all wharves, bulkhead and pierhead lines and channel and anchorage limits, as well as the present depth of water in the channels and at the docks.

A Bill Requiring Engineers in Pennsylvania to be examined and licensed in order to practice their profession has been drafted by a Commission of which Prof. John P. Jackson, of State College, Penn., is the chairman, and the other members are Samuel A. Taylor, George S. Webster, F. Herbert Snow and J. Murray Africa. The bill requires every one practicing any branch of the engineering profession other than military engineering, after June 30, 1916, to be registered as a professional engineer, and provides for examinations by a State Board of Examining Engineers. A fee of $10 is required. Hearings on the proposed bill were held by the Commission at the Engineers' Society in Pittsburgh, Oct. 15 and 16, at the Engineer's Club of Philadelphia, on Monday, Oct. 19, and in Harrisburg, at the Engineers' Club, on Oct. 28.

A Humphrey Direct-Acting Explosion Pump for Irrigation Service at Del Rio, Texas

The first installation in this country of a large-size Humphrey direct-acting explosion pump, now being made on a Texas irrigation project, is of unusual interest. It will be used by the G. Bedell Moore Estate, which has planned for some time the irrigation of a tract along the Rio Grande, of twelve thousand acres, between Del Rio and Eagle Pass.

Alexander Potter, Consulting Engineer of New York City, was retained to pass upon the most economic plan of development and recommended pumping, preferably by Humphrey pumps, instead of a long and hazardous gravity canal. The Moore Estate commissioned Mr. Potter to study the European installations of this type and the detail plants of the immense Mix (Egypt) plant now under construction. As a result of these investigations, together with a study of the original research work done by the American company, the Moore Estate has purchased Humphrey pumps and Akerlund-type producers for wood and coal burning.

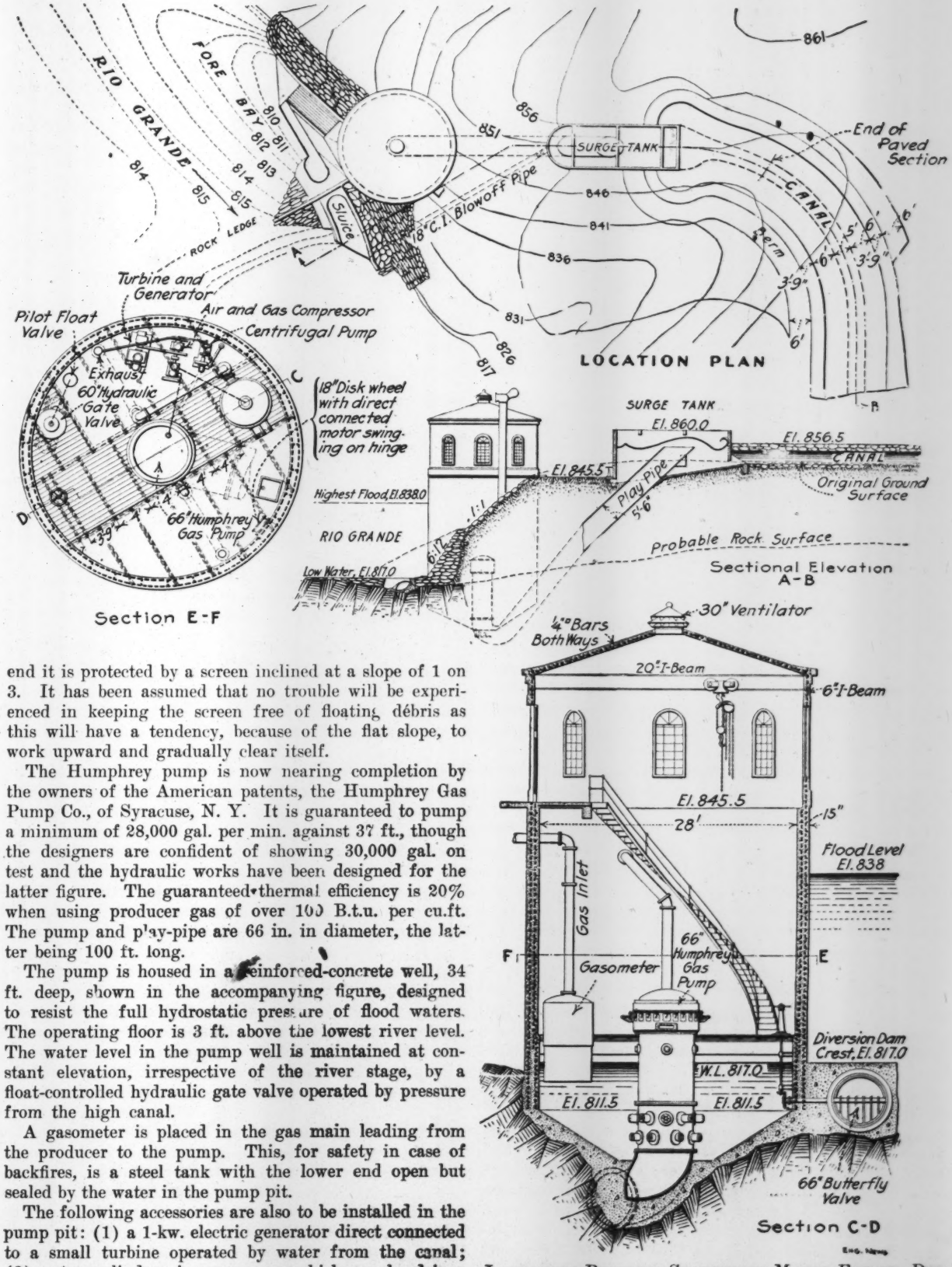
USE OF HUMPHREY PUMP—In designing the pumping plant, two types of machinery units were studied: (1) A centrifugal pump driven by an internal-combustion engine; and (2) a Humphrey direct-acting explosion pump. In the decision to use the latter, the kind of fuel that could be obtained at the pumping station played an important part.

The pumping station is located some 15 miles by road from Del Rio, the nearest railroad station; Eagle Pass bituminous coal could be delivered at the plant for $4 per ton, while fuel oil would cost some $2 per bbl. Much of the land is covered with mesquite wood and will have to be cleared before cultivation. Therefore, the use of this wood as fuel until clearing was completed seemed attractive and its possibilities in gas producers has been fully investigated with highly satisfactory results to the purchasers. The estimated fuel consumption per 24 hours and fuel cost per acre-foot for a plant of 67 sec.-ft. capacity under 37-ft. lift, was as follows:

	Fuel	Consumption per 24 hr.	Fuel cost per acre-ft.
Humphrey pump and gas producer	wood	8.8 cords	$0.100
	coal	4.8 tons	$.145
Centrifugal pump and Diesel engine	oil	14 bbl.	0.211
Centrifugal pump, gas engine and producer	wood	11.4 cords	0.128
	coal	6.1 tons	0.185

Thermal efficiencies: Humphrey pump, 20%; gas engine, 24%; Diesel engine, 32%; gas producer on lignite fuel, 75%; gas producer on wood fuel, 65%. Mechanical efficiency of centrifugal pump, 65%. Coal of 12 000 B.t.u. per pound at $4 per ton. Fuel oil of 18,000 B.t.u. per pound at $2 per barrel. Mesquite wood at $1.50 per cord (2500 lb.), 5000 B.t.u. per pound.

PUMPING STATION—The pumping station, as shown in the accompanying general plan is located directly upon the banks of the Rio Grande River at a point where a rock ledge extends entirely across and creates a slight fall. A forebay is being excavated in the river bed adjacent to the pumping station and just above the ledge. At the downstream end, the forebay is being closed by a small concrete dam and in this is placed a 66-in. circular sluiceway which can be closed by a 66-in. butterfly valve —operated from the interior of the station. Normally, this valve will be kept open so as to keep the forebay free of silt deposits, as the river is very muddy. The intake to the pumping station is 5 ft. in diameter. At its outer



IRRIGATION PUMPING STATION OF MOORE ESTATE, DEL RIO, TEXAS

end it is protected by a screen inclined at a slope of 1 on 3. It has been assumed that no trouble will be experienced in keeping the screen free of floating débris as this will have a tendency, because of the flat slope, to work upward and gradually clear itself.

The Humphrey pump is now nearing completion by the owners of the American patents, the Humphrey Gas Pump Co., of Syracuse, N. Y. It is guaranteed to pump a minimum of 28,000 gal. per min. against 37 ft., though the designers are confident of showing 30,000 gal. on test and the hydraulic works have been designed for the latter figure. The guaranteed thermal efficiency is 20% when using producer gas of over 100 B.t.u. per cu.ft. The pump and play-pipe are 66 in. in diameter, the latter being 100 ft. long.

The pump is housed in a reinforced-concrete well, 34 ft. deep, shown in the accompanying figure, designed to resist the full hydrostatic pressure of flood waters. The operating floor is 3 ft. above the lowest river level. The water level in the pump well is maintained at constant elevation, irrespective of the river stage, by a float-controlled hydraulic gate valve operated by pressure from the high canal.

A gasometer is placed in the gas main leading from the producer to the pump. This, for safety in case of backfires, is a steel tank with the lower end open but sealed by the water in the pump pit.

The following accessories are also to be installed in the pump pit: (1) a 1-kw. electric generator direct connected to a small turbine operated by water from the canal; (2) a two-cylinder air compressor which can be driven either by the turbine or by an explosion engine operated

by producer gas or gasoline; (3) a 3-in. centrifugal pump belted to the gas engine of the air compressor for draining the pump well.

Special attention has been given to ventilating the pump house. The top of the conical roof of the superstructure is provided with a 36-in. exhaust cowl. Fresh air is admitted to the pump pit at the operating floor level through a 24-in. pipe with a top cap designed to force air down by wind action. The pipe opening into the pit carries an 18-in. motor-driven blower on hinges so as to be swung into place for service when the wind velocity is too low to secure sufficient natural ventilation.

The play-pipe discharges into a reinforced-concrete surge tank 36x12 ft. The discharge pipe extends 9 in. above the normal water level in the canal. The guaranteed lift of the pump is fixed at 37 ft.; as this is not sufficient to irrigate a tract of some 500 acres in the immediate vicinity of the pumping station, it is intended to use the wave action in the surge tank to raise a small quantity of water 4 or 5 ft. above the elevation in the supply canal. The arrangement for this is not shown on the accompanying figure. The surge tank is also designed to act as a grit chamber, the grit to be washed into the river through an 18-in. cast-iron pipe.

Pump Operation—The operation of the Humphrey-type pump has been noted in Engineering News from time to time (particularly in the issues of Dec. 2, 1909, p. 603; Apr. 17, 1913, p. 764; Dec. 25, 1913, p. 1331) so that it will be but briefly noted here. A charge of gas-air mixture is exploded in a chamber above the water surface, no piston being used. The explosion drives the water downward, closes the water inlet valves and sets the whole water column in the play-pipe in motion. The inertia of the moving column of water permits the burned gases to expand below atmospheric pressure when both exhaust and water valves open. There follows a return surge of the liquid column until the water reaches the exhaust valves and closes them by impact. There is a second forward surge set up by the trapped and compressed gases and when the pressure again falls below atmospheric a fresh charge of gas and air is drawn in. This is finally compressed by the second return surge and exploded, when the cycle repeats. The inlet and exhaust valves are interlocked so that the proper sequence of operation is maintained.

In the American adaptation of the Humphrey designs, the complicated arrangement of rods and bell cranks by which the interlocking is accomplished on the large Chingford pumps in England, has been superseded by a simple sprocket chain thrown around the valve belt, engaging valve-arm studs and moving a short distance first in one direction and then in another to shift the lock from one set of valves to the other. The period of oscillation is about proportional to the square root of water-column length; in this case the pump will have approximately 12 cycles per minute.

There will be two types of ignition equipment: (1) jump-spark plugs operated from storage batteries and coils, and (2) "wipe-spark" or arc igniters taking current from the turbine-driven generator. To start, an initial charge of gas and air will be forced in by compressed air, all the valves being held shut. After explosion the play-pipe oscillations thus initiated are strong enough to work the valves and make the pump begin regular operation.

Gas-Producer Plant

The producer house will be located very close to the pump house on higher ground.

The producer system is that of the Standard Gas Power Co., of New York. It comprises a vertical down-draft generator with a water pan on top and a vapor ring around the combustion belt; air is admitted to the vapor ring and the mixture of air and steam enters the fuel chamber above the green charge. The gas is led off through a spray-cooler, a wet scrubber, exhauster, dry purifier and delivery pipe. The following figures were obtained on trial runs of the producer with mesquite wood.

Average wood burned per hour	436 lb.
Average gas made per hour	23,850 cu.ft.
Average gas made per lb. of wood	54.7 cu.ft.
Average B.t.u. per cu.ft. of gas	114.5
Average lb. of wood per sq.ft. of fire area	20.8
Lb. of wood per horsepower-hour	1.76

The pumping plant will be completed by Jan. 1, 1915. The construction of the pumping station, intake works and canal is being executed by company forces. Mr. J. H. Savage is General Manager of the Moore Estate. Whiteaker & Washington, Engineers, San Antonio, designed and are in charge of the canal work.

Water Disinfection by Liquid Chlorine at Wakefield, Mass.

By Edward C. Sherman*

The water-supply of Wakefield, Mass., is taken from Crystal Lake, in the outskirts of the town, and pumped directly into the mains, a stand-pipe serving to take the excess and to afford a night supply. The lake, although fed by many springs, receives considerable surface water which, with increase of population on the watershed, caused the quality of the supply to become unsatisfactory at times.

The amount of water available is limited and a new source will have to be found before many years if the town continues to grow as it has in the past, the population having nearly doubled in the last 25 years. As Wakefield is only about ten miles from Boston, it is probable that it will increase in size and also that it may be found desirable to enter the Metropolitan Water-Works system with which a physical connection for emergency use now exists.

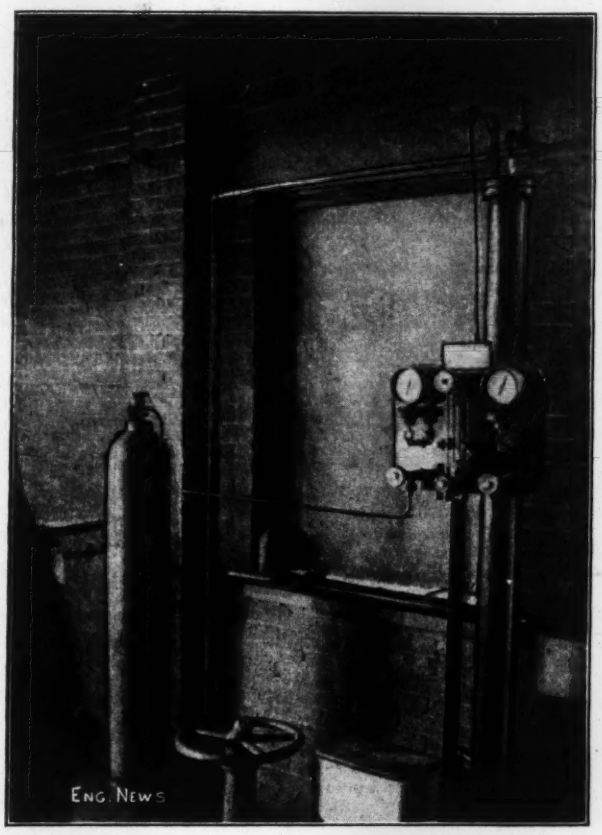
For this reason, and as the water of Crystal Lake is satisfactory in appearance, the town did not feel justified in constructing a filter plant, but the Water Board decided to continue its use provided it could be made safe at all times at not too great a cost. Upon the recommendation of the writer, it was decided to disinfect the water by chlorine gas and the necessary apparatus was installed.

The apparatus, which is shown in the illustration, consists of a gas tank, control board and absorption tower. The chlorine is received in liquified form in steel cylinders containing about 100 lb. Opening the valves on the tank and the control board permits the chlorine to vaporize and the gas passes through the copper tube to the high-pressure gage on the right of the control board. It next passes through a pressure-reducing valve, the low pressure then being shown by the gage at the left side of the board, and after flowing through a rate-control valve, en-

*Consulting Engineer, Boston.

ters the tower, behind the control board, where it is absorbed by a small spray of water. The chlorine solution is then allowed to flow into the pump suction, where it mixes with the supply and sterilizes it.

The rate of pumping is very nearly constant, the standpipe taking care of fluctuations in the rate of consumption, so that the rate of application of the gas is satisfactorily controlled by hand, by a tangent screw on the valve, the gage showing the amount being used in ounces per hour. The rate-control gage consists of a glass tube, ground on the inside to form a truncated cone, and a peculiarly



LIQUID-CHLORINE INSTALLATION FOR WATER DISINFECTION AT WAKEFIELD, MASS.

shaped platinum float, which can move up and down in the tube. The gas, in passing upward through the tube, flows through the annular space around the float and raises it to the point where the area of the opening is sufficient. With a small flow the float remains near the bottom of the tube, while a larger flow raises it. Graduations on the glass make it possible to read directly the rate at which the gas is passing.

As a check on the rate of using the gas, the tank is placed on platform scales and the weight is read and recorded every morning when the gas is turned on and the pumps started.

The small tank near the base of the absorption tower is directly connected with it by a pipe and serves to maintain a supply of water at a fixed depth in the bottom of the tower, the tank being provided with a float valve. The water for absorbing the chlorine is supplied through a small pipe leading to the top of the tower.

During the first month of operation of the plant, chlorine was used at the average rate of 5.8 lb. per million gallons of water, analyses showing this amount to be required to effectually sterilize the water. This amount cannot be detected in the water by taste or smell. The results have been very satisfactory, the number of bacteria in the treated water being from 1 to 12 per c.c., except for a period of five days, when a reduced rate of application of the chlorine was tried, at which time the number of bacteria rose to an average of 22 per c.c.

The apparatus was installed by the Electro Bleaching Gas Co., of New York, and its operation is under the direction of the writer. The Wakefield Water Board consists of Charles A. Dean, Chairman, Dr. J. H. Kimball and T. G. O'Connell.

Annual Convention of the American Society of Municipal Improvements

The twenty-first annual convention of the American Society of Municipal Improvements was held in Boston, on Oct. 6 to 9. There was a good attendance, a full program of papers and committee reports, a number of interesting exhibits, a harbor excursion tendered by the City of Boston and a long automobile ride, the latter provided by the local committee.

By far the greater part of the program was devoted to roads and pavements. Next stood sewers and sewage treatment, and third came garbage and refuse collection and disposal and street cleaning. Fire protection and some general municipal problems were considered and there was one paper and a written discussion on bacterial limits for raw and filtered city water-supplies.

The notable achievement of the meeting was the adoption of a large number of standard paving specifications.

The papers and committee reports were too numerous for more than a wearisome categorical summary here, and will all appear in the annual proceedings of the Society. We shall therefore confine our report of the convention to the business proceedings, and chiefly to the action on standard specifications and forms.

In his brief presidential address, Edward H. Christ, of Grand Rapids, Mich., remarked that the convention then being opened was the first one since amalgamation with the Association for Standardizing Paving Specifications. Without doubt, he said, the greatest work of the society has been on standardizing specifications and report forms.

The report of C. C. Brown, Secretary of the society, showed an excess of about $740 in receipts over expenditures and a total membership of nearly 500. There were 239 active and 9 affiliated members; 30 municipal members, with 67 delegates; and 68 associate members, with 81 representatives.

Dayton, Ohio, was chosen as the next meeting place by a vote of 39, against 19 for New Orleans and 5 for Buffalo.

The president chosen for 1914 was Wm. A. Howell, Engineer of Streets, Newark, N. J. Charles Carroll Brown, Editor of "Municipal Engineering," Indianapolis, Ind., was reëlected Secretary.

ADOPTION OF STANDARD PAVING SPECIFICATIONS

For some years past the society has had a general committee and various sub-committees on paving specifica-

tions. As a result, a number of paving specifications were submitted to previous meetings and some of them adopted by the Society. Working along the same general lines and to a considerable extent through the same men, the Association for Standardizing Paving Specifications, which held its last meeting in 1913, also adopted standard paving specifications. Since amalgamation, the paving specification committee and sub-committees of the American Society of Municipal Improvements have harmonized the two sets of specifications, made some revisions in them, and added others.

The general committee (Geo. W. Tillson, Consulting Engineer to the Borough President of Brooklyn, N. Y., Chairman) recommended the adoption of the following specifications, as submitted by sub-committees, with chairmen as stated in parentheses: Stone Block (H. H. Schmidt); Brick (E. H. Christ); Concrete (C. E. P. Babcock); Broken Stone and Gravel, the same with Bituminous Surface, and Bituminous Macadam (Prof. A. H. Blanchard); and Ashphalt (Francis P. Smith). This recommendation was adopted.

The general committee recommended and the meeting voted that the Wood Block specifications (Ellis R. Dutton, Chairman sub-committee) be printed; that the sub-committee be authorized to confer with the lumber and wood preservers' associations and that the specifications come up for action next year.

As to Bituminous [Concrete] Pavement specifications (Linn White, Chairman sub-committee) the general committee indorsed and the meeting approved the recommendation of the sub-committee that the latter be allowed three months' time to draft and submit to the general committee two sets of specifications: one to follow the bitulithic patents and one to avoid infringement of those patents. The understanding was that if these specifications meet with the approval of the general committee, then they shall be accepted tentatively until the next meeting and come up for adoption at that time.

Standard Sewer Specifications

The same general committee (which is really one on Standard Specifications for all classes of municipal engineering work) also recommended the adoption of Sewer Specifications (E. J. Fort, Chairman of sub-committee) except that two sections shall be left open and alternates provided. This recommendation was adopted.

The reports of the general committee and the eight sub-committees on Specifications were presented and adopted in perhaps an hour and a half. A few questions were asked, to get explanations, but there was no discussion. In fact, Mr. Tillson stated, in effect, that discussion with the idea of changes from the convention at large, would not be fitting, since the various committees had given hearings for the very purpose of general discussion. The proper course, Mr. Tillson urged, would be to adopt the specifications and then for individual members to submit suggestions for changes during the year, if they so desired. The case for such action was put strongly because at an earlier session, and before many of the reports had been submitted, a resolution had been introduced which, if carried, would have postponed any action on the reports for a year, except receiving and printing them.

The society voted to print the specifications adopted, supply one set to each member, and sell the remainder at $2 a set.

Report of Committee on Standard Forms

The chief progress made by this committee (J. C. Hallock, Deputy Chief Engineer, Newark, N. J., Chairman) was the submission through a sub-committee (E. S. Rankin, Chairman) of some forms for reporting sewerage operations. In accordance with the recommendations of both committees, a tabular form for reporting new construction was adopted and several other forms were ordered printed for consideration. Suggestions for conference with the Sanitary Section of the Boston Society of Civil Engineers, which adopted standard report forms some years ago, were not acted upon; but the one form actually adopted has no parallel in the Boston Society forms.

A sub-committee on Street Cleaning and Disposal (J. T. Fetherston, Chairman) reported that the poor success of the American Public Health Association in collecting statistics in accordance with the form devised by a committee of its Sanitary Engineering Section indicated that detailed data on street cleaning and refuse disposal are not available. The sub-committee presented a list of questions which it proposed to send out asking for information. Answers to these questions may be of immediate use as data, besides aiding in making up forms in the future.

NEWS NOTES

The Panama Canal Toll Receipts for September are reported to have been $147,000.

Asphalt Pavement Contracts to the amount of $170,000 have recently been awarded in Richmond, Va.

A Highway Bridge collapsed under the weight of a heavily loaded furniture van, at Roxbury Mills, Md., Sept. 28. The load is said to have exceeded that for which the bridge was designed. The bridge was about ten years old.

A Collision between a passenger train on the Chicago & Eastern Illinois R.R. and a motortruck loaded with 80 quarts of nitroglycerin occurred at a grade crossing in Hazelton, Ind., Sept. 24. One of the front wheels of the motor truck was torn off, but the nitroglycerin did not explode.

Ground Was Broken for the New East River Tunnels of the New York City subways from the Battery to Brooklyn on Oct. 13. The ceremonies took place at the foot of Whitehall St., and were attended by the Mayor, the members of the Public Service Commission and invited guests. The contractors are the O'Rourke Engineering Construction Co. and Booth & Flinn. The contract price is nearly $12,500,000.

The Lakes-to-the-Gulf Deep Waterway proposed by the State of Illinois has been reported upon by the board of supervising engineers. Three routes are outlined by which an 8-ft. waterway may be built from Chicago to the Illinois River at La Salle. The recommended plan provides for the use of the Chicago Drainage Canal to Joliet, then of 15 miles of the Illinois & Michigan Canal to Illinois River. The estimated cost of this project is $3,075,000.

Free Moving Picture Exhibits were given in the city parks of St. Louis during the summer months. Two wagons were sufficient to transport the entire exhibit, including the folding chairs used for the audience, from park to park. In this way 56 entertainments were given during the summer in 14 different parks. The expenses were within the appropriation of $2000. It is proposed to continue the exhibit in the city school buildings during the winter months.

Paving Progress in Baltimore, Md.—It is reported that the Paving Commission will ask the Board of Estimate for another appropriation of $1,000,000 next year from the $5,000,000 loan. At the end of the present season, it is stated, the commission will have paved about 80 miles of streets since the new paving program was commenced in 1911. There is $1,500,000 left of the original $5,000,000, which it was estimated would pay about half the cost of repaving the entire city. Another $5,000,000 is expected from a special paving tax during the next ten years.

New York Subway Construction Work continues to make satisfactory progress. There are now about 17,000 men engaged in construction work on the new subway and elevated lines. Contracts have been awarded for 59 of the 83 sections to be built. On some of the older contracts awarded in 1911 and 1912 the work is nearing completion and there are several stretches of completed structure in Lexington Ave., lower Broadway and Fourth Ave., Brooklyn. The Centre St. loop has been in operation some months. Work has recently been begun on the two-track Whitehall St. line, connecting the Broadway subway with the proposed new East River tunnels to Montague St., Brooklyn. Work has also been begun recently on both the new East River tunnels.

The Purchase of the Water-Works of the Spring Valley Water Co., San Francisco, Calif., will be submitted to popular vote next December, in accordance with action taken on Sept. 29 by the Board of Supervisors of San Francisco. The purchase is strongly advocated by City Engineer M. M. O'Shaughnessy, Mayor Rolph and the Advisory Water Committee.

The following estimates of values were arrived at after careful examination by City Engineer O'Shaughnessy and other experts in the employ of the city:

Physical properties	$13,922,534
Real estate in San Francisco	1,100,000
Lake Merced, 823 acres	1,647,340
Outside lands, 67,348 acres	6,734,800
Rights-of-way	520,000
Reservoir sites	5,022,072
Water rights	3,350,000
"Going concern"	2,500,000
Total	$34,796,746

The water company has agreed to accept $34,500,000 for its holdings. The acquisition of the water company's holdings by the municipality would end protracted litigation between the city and the company.

The Interstate Irrigation Commission held a preliminary meeting for organization at Helena, Mont., Oct. 1 and 2. Of the 16 arid and semi-arid states, nine were represented by delegates appointed by the respective governors. An organization was perfected with Ira P. Englehart, of North Yakima, Wash., as President; W. D. Beers, State Engineer of Utah, as Vice-President, and A. W. Mahon, State Engineer of Montana, as Secretary. It was agreed that the first regular meeting should be held in the City of Washington in December Various resolutions were introduced and discussed, but are to be acted upon at the next meeting, time being thus allowed for their full consideration. The most important of these resolutions looks toward the strengthening and unification of state laws regarding irrigation districts with a view to entering into contracts with the National government by which the present irrigation works built by the U. S. Reclamation Service may be turned over to the districts at the earliest practicable date and the funds thus released be used as soon as possible in building other works, and in completing some of the meritorious schemes begun and partly finished under the terms of the Carey Act, the state district and other laws. It is hoped by some such action to relieve the distress of the settlers on these projects and to overcome the general stagnation in the development of the resources of the arid West.

PERSONALS

Mr. E. B. Patterson has resigned as Engineer of the City Park Board of Dallas, Tex.

Mr. C. H. Blackman has been appointed Principal Assistant Engineer of the Louisville & Nashville R.R., with offices at Louisville, Ky., succeeding the late J. Werness.

Mr. L. E. Marshall has resigned as General Superintendent of the Illinois Northern Utilities Co., to become General Manager of the properties of the Missouri Gas & Electric Co., Lexington, Mo.

Mr. Harold Knight, former Division Engineer of the Erie R.R. at Jersey City, N. J., has been appointed Signal Engineer, with headquarters at Jersey City, succeeding Mr. W. H. Willis, resigned.

Mr. A. M. Acheson, recently Chief Engineer of the Missouri, Kansas & Texas Ry., at Dallas, Tex., has been appointed Superintendent of the Trinity district, with headquarters at Trinity, Tex. The office of Chief Engineer is abolished.

Mr. C. A. Thanheiser, Assoc. M. Am. Soc. C. E., recently Engineer of Maintenance-of-Way of the Missouri, Kansas & Texas Ry. of Texas, at Dallas, Tex., has been appointed Superintendent of the Smithville district, with headquarters at Smithville, Tex.

Mr. Charles F. Lacombe, F. Am. Inst. E. E., has resigned as Chief Engineer of the Bureau of Gas and Electricity of the Department of Water Supply, Gas and Electricity, New York City, effective Nov. 12. Mr. Lacombe has been connected with the department since 1903.

Mr. Harry Edward Prindle, formerly Canadian representative of Messrs. Palmer, Hornbostel & Jones, Architects, has opened an office at 915 New Birks Bldg., Montreal, Que., for the general practice of architecture. The Montreal office of Palmer, Hornbostel & Jones has been discontinued.

Mr. D. W. Chamberlain, for the past two years Resident Engineer of the California Highway Commission, has been promoted to be Assistant Division Engineer with headquarters at Fresno, Calif. Mr. Chamberlain was connected with the New York State Highway Department before going to California.

Mr. Frank Ringer, recently Superintendent of the Missouri, Kansas & Texas Ry., at Muskogee, Okla., has been appointed Engineer of Maintenance-of-Way, with headquarters at Parsons, Kan., to succeed Mr. L. F. Lonnbladh, promoted, as noted elsewhere. Mr. Ringer was Engineer of Maintenance-of-Way until a short time ago.

Mr. L. F. Lonnbladh, Engineer of Maintenance-of-Way of the Missouri, Kansas & Texas Ry., at Parsons, Kan., has been appointed Engineer of Maintenance-of-Way of the Missouri, Kansas & Texas Ry. of Texas, wtih headquarters at Dallas, Tex., succeeding Mr. C. A. Thanheiser, Assoc. M. Am. Soc. C. E., promoted, as noted elsewhere.

Mr. H. S. R. McCurdy, M. Am. Soc. C. E., Division Engineer in charge of the construction of the Ashokan Reservoir, Catskill Water Supply, has resigned as a member of the engineering staff of the Board of Water Supply, New York City, to go to Dayton, Ohio, with the Morgan Engineering Co., on the Miami River flood prevention work.

Mr. John P. Newton, Assoc. M. Am. Soc. C. E., Assistant Engineer, formerly in charge of the Bureau of Hydraulics, New York State Barge Canal, Albany, N. Y., has been granted leave of absence to become Engineer in charge of water supply investigations for the proposed new Pennsylvania canal system, with headquarters in Pittsburgh, Penn.

Mr. Elmer E. Bernard, Assoc. M. Am. Soc. C. E., formerly Assistant City Engineer of Lynchburg, Va., has resigned, effective Oct. 1, to become Engineer of Roadways of the Lynchburg Traction & Light Co. and the Roanoke Ry. & Electric Co. Mr. Bernard will divide his time between Lynchburg and Roanoke, Va., but will make his headquarters in Lynchburg.

J. H. Dockweiler, Consulting Engineer for the City Attorney of San Francisco, has been appointed by the City Council of Oakland, Calif., Municipal Water Expert, at a salary of $4000 per year. The appointment will not interfere with Mr. Dockweiler's consulting practice. He will be in direct charge of collecting data for rate suits and will represent the city in all water litigation.

Mr. John J. Long, for the past four years a member of the engineering faculty of Brown University, has been appointed Instructor in Civil Engineering in the University of Cincinnati, where he will teach sanitary and highway engineering. Mr. Long is a graduate of the Sheffield Scientific School, Yale University, and has been connected at various times with the Pennsylvania Lines West of Pittsburgh, the City Engineer's Office of Woonsocket, R. I.; the Bronx Bureau of Design, New York City, and more recently was Assistant Engineer in the Bureau of Highways, Borough of Queens, New York City.

Mr. A. B. Nichols, Office Engineer, under the Engineer of Maintenance, Panama Canal, has resigned and has returned to his old home in Philadelphia, Penn. Mr. Nichols was the oldest employee, in point of service, of the Panama Canal engineering staff. He was appointed to the canal service in May, 1904, and until June, 1905, was Assistant Engineer at Gatun. He was promoted to be Resident Engineer in the Culebra division, and in July, 1906, was made Office Engineer at Culebra, which position he has held ever since. Mr. Nichols was Division Engineer from 1899 to 1901 of the old Isthmian Canal Commission, and he had charge of the surveys for the Nicaraugua canal route.

Mr. C. J. Reilly, formerly General Superintendent of the Sandusky Portland Cement Co., and for the past year Consulting Engineer for the design, construction and operation of portland cement plants, with offices at Syracuse, Ind., has been appointed General Superintendent of the Sterling Portland Cement Corporation, a concern organized to take over and complete the plant started by the Seaboard Portland Cement Co., near Catskill, N. Y. This plant uses limestone

and shale and was originally designed and partly completed on the dry process. Mr. Reilly proposes to redesign the entire plant to use the wet process, for the purpose of eliminating dust in the vicinity of the mill, and to make other improvements.

Mr. Frank W. Skinner, M. Am. Soc. C. E., for many years Senior Associate Editor of "The Engineering Record," has opened consulting offices at 45 Broadway, New York City, and in the Crabtree Annex, St. George, Staten Island. Mr. Skinner is associated with Mr. C. E. Fowler, M. Am. Soc. C. E., of Seattle, Wash., and will specialize in bridge and structural steel work, foundations and general civil engineering field construction methods. He will also specialize in the preparation of engineering cases for litigation, expert witness research and testimony, preparation and mediation of cases in controversy and in the preparation of technical, commercial, popular and miscellaneous descriptions of engineering construction.

Mr. Dwight B. La Du, Assoc. M. Am. Soc. C. E., former Division Engineer, Department of the State Engineer of New York, has been promoted to be Special Deputy State Engineer, in charge of the Barge Canal work, to succeed Mr. Alex. E. Kast, M. Am. Soc. C. E., whose resignation was noted in these columns of Sept. 24. Mr. La [illegible]as been connected with the Barge Canal work since [illegible]eginning with the running of precise levels in the Mohawk Valley in 1900-1901. Later he was Assistant Engineer in charge of the construction of locks and canal in the vicinity of Whitehall, N. Y., and on the Champlain division of the Barge Canal. More recently he has been Division Engineer of the Eastern division, with headquarters at Albany, N. Y.

OBITUARY

Michael V. Kennedy, a well known public-works contractor of Des Moines, Iowa, died Sept. 25. He was born in Ireland in 1857.

Henry N. Hamilton, a retired civil engineer, died Oct. 7, at his home in Yonkers, N. Y., aged 64 years. He was a great-grandson of Alexander Hamilton, of Revolutionary fame.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20-22. Convention at Los Angeles, Calif. Secy., C. A Lichty, 319 North Waller Ave., Chicago, Ill.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Oct. 20-23. Annual convention at New Orleans. Secy. James McFall, Roanoke, Va.

AMERICAN GAS INSTITUTE.
Oct. 20-23. Annual meeting in New York. Secy., George G. Ramdell, 29 W. 39th St., New York City.

NORTHWESTERN ROAD CONGRESS.
Oct. 28-31. Congress at Milwaukee, Wis. Headquarters, 71 Sentinel Bldg., Milwaukee, Wis.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

INDUSTRIAL WELFARE AND EFFICIENCY CONFERENCE.
Nov. 16-20. Conference at Harrisburg, Penn. Secy., R. M. Pennock, Harrisburg, Penn.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 19-20. Annual meeting at Columbus, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Nov. 30—Dec. 1. Annual meeting at New York. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEER'S.
Dec. 1-4, Annual Meeting at New York City. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 2-4. Convention at Washington, D. C. Secy., D. Knickerbacker Boyd, The Octagon, Washington, D. C.

AMERICAN MINING CONGRESS.
Dec. 7-11. Annual meeting at Phœnix, Ariz. Secy., J. F. Callbreath, Denver, Col.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 9-12. Convention at Richmond, Va. Secy., C. A Prosser, 140 W. 42d St., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 10-11. Annual meeting at New York City. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Madison, Wis. Secy., F. M. White, Madison, Wis.

Engineers' Club of Jefferson City, Mo.—This club was recently organized with 31 charter members. H. B. Shaw, a member of the Missouri Public Service Commission, is President.

Indiana Electric Light Association—The annual convention was held in Indianapolis Sept. 24 and 25. The following officers were elected: President, T. E. Grover, Terre Haute, Ind.; Secretary, Thomas Donahue, Lafayette, Ind.; Treasurer, Fred L. Dennis, South Bend, Ind.

Conference of Mayors on the Regulation and Control of Public Utilities—Mayor Blankenburg, of Philadelphia, has invited the mayors of 75 large cities to meet in Philadelphia Nov. 12, 13 and 14 to discuss public policies in regard to the municipal regulation and control of public utilities. The scheme has the indorsement of the mayors of New York City, Chicago, Cleveland and Dayton. The American Academy of Political and Social Science is cooperating with Mayor Blankenburg.

American Society of Mechanical Engineers—The nominating committee, consisting of John E. Sweet, Charles Whiting Baker, John H. Barr, A. M. Hunt and P. W. Gates, have made the following nomination of officers for the coming year: For President, Dr. John A. Brashear, of Pittsburgh, Penn.; for Vice-Presidents, Henry Hess, of Philadelphia, Penn.; George W Dickie, of San Francisco, Calif., and James E. Sague, of Poughkeepsie, N. Y.; for Managers, Charles T. Main, of Boston, Mass.; Spencer Miller, of New York City, and Max Toltz, of St. Paul, Minn.; to fill the unexpired term of the late Alfred Noble, Morris L. Cooke, of Philadelphia; for Treasurer, Wm. H. Wiley, of New York City.

Philadelphia Association of Members of the American Society of Civil Engineers—The annual meeting was held Oct. 5, with Hunter McDonald, President of the American Society of Civil Engineers, was a guest. The fundamental principles of the proposed federation of engineering activities in Philadelphia were approved by the meeting. The tentative draft of an act prepared by the Engineers' Commission of Pennsylvania for licensing engineers in that state was discussed. The Philadelphia Association was formally organized less than a year ago with 26 members. The membership has now reached 107, and the interest shown in the meetings indicates that it fulfills the purpose for which the association was organized.

The following officers have been elected for the ensuing year: President, Richard L. Humphrey; Treasurer, S. M. Swaab; Secretary, W. L. Stevenson.

STATEMENT OF THE OWNERSHIP, MANAGEMENT CIRCULATION, ETC., OCT. 1, 1914,

of Engineering News, published weekly at New York, N. Y., required by the Act of August 24, 1912.

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C. W. Dibble, Vice-President,
HILL PUBLISHING COMPANY.

Sworn to and subscribed before me this 30th day of September, 1914.

RICHARD L. MURPHY,
Notary Public.
(My commission expires March 30, 1915.)

Engineering Literature

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REVIEWS AND NOTES

How Can Engineers Best Utilize the Technical Journals?*

By John W. Alvord†

That we cannot keep abreast of the times without reading the engineering journals is obvious. That if we carefully read all the engineering journals in our chosen specialty we would have no time left to earn a living is easily capable of demonstration. What, then, is the proper attitude to adopt toward this ever increasing flood of information that pours in upon us so relentlessly?

The problem of the engineer with his technical paper is much affected by his age, station, and aim in life. To the man who is in engineering only to get money and more money, the engineering journal is a newspaper, in which he may notice mainly where there are better jobs than his own that may be sought after and perhaps obtained. To the man who is anxious to fit himself every year of his life for something better, it is an opportunity, quite unequaled many years ago, for a great variety of study. To the young engineer, the engineering journal, properly read and noted, is part of a post-graduate course in engineering. To the middle-aged man, it is a mine of data, bearing in all sorts of ways on his work, and to the mature specialist only does it begin to become burdensome by its repetition of experience, and its volume of matter on subject which has already, to him at least, been well digested.

Let us see if we can outline how each of these classes can get more profit out of the matter contained in the engineering journals than do the careless or the indifferent who, after their journal is once looked over, let it go to waste or idleness.

The young engineer should, as early as possible, take at least one good first-class engineering journal, and own it himself; bind it, if he can afford to, but lay it away in an orderly manner, in any event. If he can afford two journals, so much the better, especially if they are selected so as to widen his outlook. If one might advise, it would be to suggest enforced systematic reading of all articles particularly bearing on the line of work the reader is immediately engaged upon, and the optional reading only of such other articles as interest him.

It is probably not wise for the young engineer to indulge extensively in card indexes, filing systems, and the like, for topically arranging his available engineering journal articles. Few men know very early in life where fate and interest will land their future attention, and filing systems and special indexes are expensive and time consuming, and when indulged in without definite aim nearly always quickly become too voluminous and thereby useless. Many a young engineer has spent many weary hours filing and indexing only to abandon his system later or in despair at the quantity of material he early collects and the difficulties of making it quickly available.

If any suggestions are made along this line, it would be to start a loose-leaf letter-size (8½x11-in. page) notebook, and note in it (separate pages for separate subjects) only what appears to be extremely useful, either in exceedingly brief abstracts from engineering articles or diagrams, costs, etc. These notes will be most useful if they are confined to that kind of work in which the compiler is immediately engaged, and has on his mind at the time, or at the most, work very similar to his own, which has perhaps had his personal inspection.

If any such book is started, it is highly desirable that it be of letter size, because that is nowadays the working size to which all sorts of documents, engineering reports, and estimate work are approximating. Pocket notebooks, card indexes and odd sizes of notebooks should be avoided, if possible, as likely to be finally abandoned. The letter size fitting the stock office furniture and ordinary typewriter is much more likely to endure with the average man as a permanent system.

We next come to the man in early middle life, actively engaged in his profession, and note at once that his problem with the technical journal is the absence of "time." If he is largely engaged in administrative work, or is a salaried officer in a large enterprise with a comparatively limited range of problem, or a limited call for miscellaneous data, he may generally be content with a cursory examination of the engineering journal such as will keep him qualified on his undertaking, and the preservation of such journals in bound form, with the standard published indexes. If, however, he is entering upon novel work, or work presenting a great variety of problems, overlapping into a great variety of fields, ambition will compel him to do more than this, and some form of special indexing will appeal to him more or less strongly as he feels the need more often for research in uptodate material.

There are several methods of classifying and indexing selections from engineering literature which such an engineer may adopt.

(1) He may rely on his memory and the published index to his bound volumes.

*Extracts from a paper read at the meeting of the Federation of Trade Press Associations, at Chicago, Sept. 25, 1914.

†Consulting Engineer, Chicago, Ill.

It is safe to say, however, that few engineers really make much practical use of this method. The intervening index and the bother of a search following, prove to be discouraging to that degree that a proposed reference search is abandoned in about one-half the suggested attempts. The ideal filing system is the one in which, with the least amount of effort one can put his hand immediately and accurately on the thing itself, be it a book, a pamphlet, or a data sheet.

(2) He may keep a special card index of important data, and reference to valuable articles.

This at once involves labor and attention, which few busy men can give, and which, if done by assistants or librarians, largely loses its personal value to the one who needs it. The same objection as to the discouraging effect of intervening indexes holds good here, too, and it is further safe to say that of all the contrivances for indexing, the most difficult to readily handle and rapidly examine is the card-index system

(3) He may abstract important data in a limited way on loose-leaf transparent paper, standard letter size, and he may remove or detach articles of special value from out his journals, to be filed in regular office file system, like correspondence.

The writer has tried all of the above methods at considerable cost in time and patience, and has, for many years, settled upon the third method above outlined. With all its admitted limitations it seems to be the best for an office which is expected to find out information on a great variety of subjects in a limited time, and with the least amount of effort.

Some description of its practical workings may be of interest.

All the technical papers of the office pass on to the desk of the head of the office and are at least looked over (not read) by him. Articles important to his particular specialty are checked with pencil, and articles of especial interest are looked over with care and double-checked. Once in a long while data important enough to go to the data file are noted. This is either especially abstracted by the stenographer, or, if a diagram or cost data, perhaps traced in the drafting room; all on transparent paper for copying purposes. Special data of this kind on 8½x11-in. sheets are filed in the office data file (a separate but common standard correspondence file). From the data file loose-leaf working notebooks are made up from blueprints for office or travel purposes. They are altered, refilled, amended, and sorted back from time to time as needed to keep them of usable volume and usefully up to date.

The technical journals, with checked articles, go to the office clerk or the stenographer at odd hours, or the librarian if one can be afforded, and the useful articles are removed by tearing them out with a ruler. They are folded, usually once, to standard size, with one edge lap left for binding, and are then filed in a subject index file, like current correspondence. The Dewey decimal system, especially arranged for the office, is used, but only as a general subject plan. When the file is full, portions of its contents, especially that which is most useful, are simply bound in plain pasteboard covers and placed in the library shelves, with titles. Such a book (or many books) would contain all the recent articles thought to be of special value on a given single subject. The remaining portions of the technical paper are thrown away, but in a large office, warranting the expense, duplicate bound copies can be kept as well, with the general published index as their key.

The objections to this system are as follows:

1. It is too expensive for any but the most important offices doing specialized work.
2. Data accumulate almost too fast unless rigidly kept down to a minimum.
3. It requires some personal attention of the head of the office, a competent assistant, or the employment of a regular librarian.

The advantages are:

1. It compels the office head to know all the time what is being published in current engineering literature, if only by inspection.
2. It removes all intervening indexes between the searcher and the final repository in the bound volume.

It keeps one's library usefully up to date on all lines in which one should be especially interested

4. It is economical of final shelf room and binding cost.

We come finally to the mature and experienced engineer of advancing years. How can he make engineering and technical literature of use?

It is safe to say that when an engineer has much passed fifty or sixty years of age, and has led an active life, in constant touch with affairs, he feels less need for accumulated data or particular description. Probably no one enjoys engineering reading as does the mature engineer, for he can read between the lines and find much to instruct as well as interest.

If his acquaintance is wide, he reads with interest the accomplishments of his friends, and the addresses of society presidents, and articles on the ethics of the profession. Of failures he is the keen student. The personal column appeals to him, and if he is of right-mindedness he is conscious of more pleasure than formerly in the accomplishments of those who have succeeded and succeeded well in dire and burdensome responsibility.

The engineering journal again becomes for him a technical newspaper of great personal interest and deep satisfaction, for no longer is he keen for jobs, or eager for data, but the human, personal, and ethical side of the life work of the engineer is uppermost in his mind, and he realizes that though he may have seemed to others, and even may have seemed to himself to have been striving all these years for emolument, as a matter of fact the deep and abiding motive of his life work has been the pleasure of being *needed* and the joy of being useful.

In conclusion, I would remark that technical papers, along with the technical societies and their proceedings, form the repository of the profession; they are the interchange of experience, the common store upon which we all draw. Without them we would be strangely helpless. We are indebted to everyone more or less who records his experience for the common use, and that debt we should endeavor to helpfully repay in kind, but wisely, concisely and thoughtfully.

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Translation of Melan's Arches and Suspension Bridges

REVIEWED BY PROF. J. P. J. WILLIAMS*

THEORY OF ARCHES AND SUSPENSION BRIDGES—By J. Melan, Professor of Bridge Design, German Technical School at Prague. Authorized Translation by D. B. Steinman, Professor of Civil Engineering, University of Idaho; author of "Suspension Bridges and Cantilevers." Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd., 57 Haymarket. Cloth: 6x9 in.; pp. x+303; 119 illustrations. $3.

This book is a complete literal translation of J. Melan's mathematical treatment of the elastic theory of arches and suspension bridges, as published in 1906, in Vol. 2, Part 5, of the German "Handbuch der Ingeneurwissenschaften." The translator states in the preface that admiration of the work of Melan and a desire to fill a gap in our own engineering literature on this subject were the impelling motives for the translation, and that he believes it will prove useful to practicing engineers and to teachers as a textbook for graduate work. He says: "The book will prove a liberal education in itself, rendering clear the fundamental principles of the analysis of structures, familiarizing the student with many helpful analytical and graphical devices of general application, training him in the independent derivation of formulas, and preparing him to do original work in structural theory and design."

Even after making full allowance for the natural en-

*Chautauqua, N. Y.; lately Assistant Professor of Structural Engineering, University of Minnesota.

thusiasm of an admirer, such a statement of the value of this book is quite evidently unwarranted. In order to justify such claims, a book on this subject should possess two definite characteristics: clear statement of notation and completeness in mathematical derivations. The book is defective in both. In order to be easily and effectively useful to both practicing engineer and student, the notation used in the many complicated formulas should be completely and clearly defined. In this book it is generally quite difficult to find the meaning of the symbols used because in nearly all cases they are defined in the body of the text, and no complete tabulated standard notation is given. In fact, in at least one case (Equation 416) the same symbol (A) is used in two entirely different ways, and often the symbols in a formula are defined after the formula is given.

The second noticeable defect is the incompleteness of the explanation and detail of the mathematical derivations. In a handbook, it is only necessary to give a concise statement of general processes and the final forms of working formulas. But for the engineer or student who really desires definite understanding of all formulas and completeness and certainty in their derivation, the book will be found to be quite unsatisfactory. Many hours of time would be required to check the mathematical formulas independently and repeat the author's omitted operations in order to confirm the accuracy of the formulas given. If mathematical gymnastics with the object of attaining a given result be the best training for engineering students, then the translator's claims for the advantages of this book as a text for graduate students are fully justified. In too many cases simple explanatory sentences stating the logical reasoning processes in detail are conspicuous by their absence, making the intelligent understanding of the mathematics unnecessarily difficult.

Aside from the defect of notation already mentioned, the book will be found most complete and useful as a reference work for formulas and both analytical and graphical methods of analysis of nearly all forms of both framed and solid arches and braced chain and cable suspension bridges. The author has undoubtedly accomplished an excellent piece of work requiring an immense amount of time and labor and great mathematical ability. It is by far the most extensive theoretical study of this subject known to the reviewer. The only incompleteness of treatment is in the theory of the continuous arch, which is not extended to include fixed ended continuous arches so extensively used in this country.

Although it has been impossible to find the time to study fully the accuracy of the translation, it appears to be both complete and exact with the exception of the translation of the word "berechnung." For example, Article 2 is headed "General Method of Design," and should be "General Method of Analysis." With this exception, the work of translation seems to be very well done.

The contents of the book are divided into five well defined sections: A—The Flexible Arch and Unstiffened Cable; B—The Stiffened Suspension Bridge; C—The Arched Rib; D—Arch and Suspension Systems with Braced Web; and E—Combined Systems. The Appendix discusses the application of the elastic theory to masonry and concrete arches, and contains short remarks on the temperature variation in steel and masonry bridges.

Section A contains two articles, one on the funicular polygon for vertical concentrated loads, continuously distributed loading and uniform loading, the other on the unstiffened suspension bridge. The latter (Art. 4) is divided into five parts, treating: (1) Form of cable and value of horizontal tension for chain (or eye-bar) cables and wire cables, and values of cross-sections required; (2) maximum attainable span, with table for various cases; (3) economic ratio of rise to span, including an example; (4) deformations and deflections under uniform loading, also effects of elongation of cable, displacement of saddles, and an example in metric units; and (5) secondary stresses due to friction at pins of eye-bar chain cable and example.

Section B, on the stiffened suspension bridge, contains five articles. The first of these, Article 5, contains the formulas for bending moments and shears in stiffening trusses, for the horizontal tension, and discusses influence lines and gives an example; this analysis being by the approximate method which neglects the effect of the deflection of the cable. Article 6 contains the expressions for values of horizontal reactions, and Article 7 the discussion of stresses in the stiffening trusses, including reaction locus, influence lines and graphical equilibrium polygon methods, effect of temperature and secondary stresses. Article 8 gives values of deflections due to loading and to temperature changes, and Article 9 contains the development of the more exact theory of the stiffened suspension bridge, with examples in metric units showing that the error resulting from the approximate theory might be a high percentage on the side of safety when light stiffening trusses are used.

Section C, on the Arched Rib with Solid Web, contains 19 articles fully developing the elastic theory of arch analysis. The first five articles discuss internal stresses in curved ribs, conditions for stability, line of resistance, core-points, graphic determination of normal fiber stresses, determination of deformations, external forces on arched rib, the reaction locus, tangent curves, and critical loading for maximum normal stresses and shears. These general formulas are then extended to apply to five different types of arch: (1) Three-Hinged Arch; (2) Arch with End Hinges; (3) Arch without Hinges; (4) Cantilever Arch; and (5) Continuous Arch. The last two articles then discuss the more exact theory of the arch, including the effect of deformation, and formulas for proportioning the section of plate-girder types of arch ribs.

In section D, the subject of framed arches and suspension systems is discussed in six articles. The treatment includes the determination of maximum stresses in members, the drawing of influence lines for three hinged and two-hinged arch frames, arch frame with tie rod, the free-ended cantilever arch, cantilever arch with ends fixed on horizontal rollers, framed arch with fixed ends, and the continuous-framed arch and braced-suspension bridge of multiple span. The example given as an illustration of the last mentioned analysis is Lindenthal's project for the Quebec Bridge, which is really an inverted two-hinged braced arch of three spans swung from rocker arms and anchored at the ends. All maximum stresses are determined, but using metric units.

Section E, on Combined Systems, contains two articles, one on the combination of an arch with a straight truss, and the other on the combination of the arched rib with a cable. The Appendix, already described, the very com-

plete bibliography, and a rather meager index complete the volume.

On the whole, the typography and figures are perfectly satisfactory. In some formulas the Greek letter alpha looks almost exactly like "a," and sometimes the bold-faced symbols are not sufficiently distinct. In at least one formula there is an evident typographical error (Formula 175, "a" should be "A"). In a few figures the lines are crowded, and in Plate 1 some of the German notes and letters were not translated, but otherwise the publishers have done excellent work.

Rock Tunneling

REVIEWED BY F. LAVIS*

MODERN TUNNELING, with Special Reference to Mine and Water-Supply Tunnels—By David W. Brunton and John A. Davis. New York: John Wiley & Sons. London: Chapman & Hall, Ltd Cloth; 6x9 in.; pp. vi + 450; 80 text figures. $3.50, net.

Recently in conversation with a group of well known and quite prominent engineers, the question was raised as to the utility of books dealing with such phases of practical work as, for instance, that of tunneling, and the opinion was expressed that as far as tunneling or work of a similar character was concerned, they would rather take the opinion of an experienced foreman or superintendent, that is of the practical workman, than anything to be found in books.

The writer has had enough practical experience to have a good deal of respect for the opinion of the intelligent, practical man, but he has felt for many years that in regard to tunneling this had been carried rather too far in the United States. This may be one of the reasons why, up to within, say, six or seven years ago, the Europeans were so far ahead of us in this class of work, which has there been almost entirely directed by engineers and here by foremen. Since engineers in this country have taken an active part in the analysis of the causes which make for rapid progress and low costs and in the active direction of the work, we have done much better here and in many respects equaled or bettered European records.

Some seven or eight years ago, the writer was asked to review the book on tunneling, written by the late David McN. Stauffer. This was really a compilation of a number of descriptive articles previously published and scattered through a number of technical papers and periodicals, and while the reviewer admitted the fact that such compilation had a certain value, he expressed the opinion that there was a great need of a book on tunneling which would thoroughly discuss the relative value of modern appliances, and the reasons for the (at that time) very poor showing (of progress) in American tunnels (as compared with European).

The introductory chapter of the book under review, which set forth its object, warranted the expectation that this need had now been met, and it is a pleasure to say at once that this expectation has been realized. The introduction states that descriptions of work done are interesting historically, but that in very few of the published descriptions "do the writers attempt to criticise the methods they are describing—or analyze methods and costs." In this volume, on the contrary, the authors state that the "making of such analyses will be a primary consideration" and that constructive rather than destructive criticism will be their object. "For that reason emphasis will be placed upon safe, efficient and economical methods and upon good points of equipment, while bad practice and obsolete machinery will be ignored except, perhaps, as examples of the inadvisable or as they have some bearing historically. Thus the authors hope to set forth a guide for future work rather than an unillumined record of past or present achievement."

The authors have confined themselves entirely to descriptions of and the discussion of methods, applicable to mine adits and small tunnels, "where the entire cross-section is excavated in one operation," and practically entirely to excavation in solid rock. This, of course, limits the scope of their work and it would seem that the book might appropriately have been entitled, Modern Rock Tunneling as Applied to Mining and Small Water-Supply Tunnels.

The first three chapters, pp. 1 to 53, are devoted first to an introduction and a statement of the purpose of the authors, second to a brief history of tunneling from the earliest beginning to modern times, and which rather strangely includes the only reference and data in the book referring to railroad tunnels, and the third, contains some data of modern mining and water tunnels, including, of course, the tunnels of the Catskill and Los Angeles aqueducts (though the former are larger than those to which the subsequent discussions refer), the Newhouse, Laramie Poudre, Carter and others well known to those who keep in touch with this subject.

Chapters 4 to 14, however, contain the matter of greatest interest. Chapters 4 to 10, pp. 53 to 207, contain descriptions of and discussions of the value of various types of machinery, power plants, compressors, tunneling machines, drills, cars, ventilation methods, etc., etc. There are many tables and the advantages and disadvantages of the many different varieties of equipment, and their particular application to various conditions are very fully and intelligently analysed.

In chapters 11 to 14, pp. 208 to 273, the various methods of drilling, blasting, mucking and timbering are treated in the same analytical manner and the discussion is so exhaustive and complete within the limits of the class of tunnels to which the authors confine it as to be of undoubted value and interest to anyone interested in the practical side of tunneling, whether engineer or foreman.

There is a chapter on Safety, one on Costs, and a Bibliography. The latter is arranged for convenient reference under some 30 different headings such as for instance, Steam Power, Water Power, Tunneling Machines, Drilling Methods, Speed Records, etc., etc. There is an index at the end which is well arranged and seemingly quite complete.

Speaking generally, this book is a distinct and quite valuable acquisition to the literature of tunneling. There is nothing at all in English which the writer knows of which has attempted to cover the same field, and the authors are to be congratulated on having accomplished a difficult task so well.

They have, however, in their discussions of methods practically entirely ignored the field of railway tunnels, or any tunnels of larger cross-section than that in which the entire excavation is made at one operation, and practically nothing is said regarding methods of tunneling in soft ground except in the chapter on timbering,

*Consulting Engineer, 50 Church St., New York City.

and this is rather brief and like the rest confined only to tunnels of small cross-section.

So far as rock tunnels of large cross-section are concerned, of course, the methods described are quite as applicable to the heading work as they are to the class of small tunnels discussed, but there are many factors controlling the operation of the excavation of rock tunnels of large cross-section which need the same kind of analysis as has been here given to the small tunnels; such, for instance, as the economies of shaft sinking, the relation of the heading to the enlargement, the questions of top and bottom headings, the use of steam shovels for mucking, the clearance of the heading operations from those of the enlargement, etc., etc.

The Bibliography occupies some sixty pages, but it is doubtful if its value is as great as that of the rest of the book, as it is far from complete. In the first section, for instance, covering "Tunnel Description," there is no reference to the two volumes of the Transactions of the American Society of Civil Engineers, describing the New York Tunnels of the Pennsylvania Railroad, or to many other articles of seemingly equal importance to those quoted, although there are included references to such works as the "The Blackwell Tunnel in London and the Tunnels of the Hudson & Manhattan Company in New York," both subaqueous, shield driven, and therefore, apparently outside of the scope of the book. It is true that there is a note to the effect that this is a "selected" bibliography, but the value of anything of this kind is largely in its completeness. Many references are duplicated under the various headings and for future consideration it might be suggested that the bibliography be made complete in one section with an index to the various subjects covered.

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How to Operate Sewage Works: A German View

REVIEWED BY EMIL KUICHLING*

ABWASSERREINIGUNGSANLAGEN IHRE LEISTUNGEN UND IHRE KONTROLLE VOM CHEMISCH-PRAKTISCHEN STANDPUNKT—Von Prof. Dr. K. Thumm, Abteilungsvorsteher an der Königl. Landesanstalt für Wasserhygiene in Berlin-Dahlem. Berlin: August Hirschwald. Paper; 6x9 in.; pp. 92. 2.80 Marks.

This monograph deals mainly with the scientific management of sewage-disposal works, and emphasizes the obligation to conserve the purity of the outfall waters into which the effluent is discharged. It frequently happens that well designed works fail to be efficient when skilled supervision is neglected, and the operation is carried on chiefly with the view of avoiding complaints about offensive odors. In such cases, a serious pollution of the outfall is often the natural consequence, and hence a careful manager must give due attention to both the plant and the outfall.

The subjects considered embrace the physical and chemical analyses of water, sewage and effluents and the operation of disposal works of every description, embracing screens, sedimentation tanks, chemical treatment, septic tanks, natural and artificial filters or biological purification processes, final purification of the effluent in fish-ponds, treatment of sludge, and the scientific supervision of the outfall; and in conclusion, a brief review of the preceding chapters is given with some general remarks about the treatment of industrial wastes. Numerous analytical data and descriptions of methods of examination are presented, together with the results attained by the various modes of treating sewage of different strength or quality.

The book is well written and contains much valuable information in condensed form. Its keynote is that the secret of a successful result in operating sewage-disposal works is careful management, guided by scientific knowledge and practical experience in securing the utmost efficiency of every available appliance.

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Multiplication by Addition, Subtraction and Division

REVIEWED BY ROSSITER R. POTTER*

COX'S COMMERCIAL CALCULATOR; A Novel and Easy Method of Multiplication, One Formula for all Calculations, Range of Results from a Single Unit to Over Ten Billions, Automatic Index to Tables—By Edward L. Cox, Southport, Lancashire, England. New York: Funk & Wagnalls Co., and the Remington Typewriter Co. Linen; 7x11 in.; pp. 101. $10.

The tables of figures making up this book may be used to find the product of any two whole numbers whose sum does not exceed 202,000. In other words, they may be used for multiplying together any two numbers having up to five digits apiece and they cover besides a limited range of six-place multiplications. The products are not obtained directly from the tables, but indirectly from "key numbers" obtained by a simple manipulation of the multiplier and multiplicand. The lesser of the two numbers to be multiplied is first subtracted from the greater. Dividing the difference by two gives the first key number.

$$\frac{A - B}{2} = \textit{first key number} \qquad (1)$$

The second key number is then obtained by adding the smaller of the numbers to be multiplied to the first key number.

$$\frac{A - B}{2} + B = \textit{second key number} \qquad (2)$$

The number in the tables corresponding to the first key number is then subtracted from that for the second key number and the resulting difference is the desired product.

The explanatory text and instructions occupying the first three pages do not tell the secret of the book's operation. A moment's consideration, however, of the algebraic form of the key numbers, as given above, shows that the book is simply a table of squares.

$$\left(\frac{A - B}{2} + B\right)^2 - \left(\frac{A - B}{2}\right)^2 = AB \qquad (3)$$

The difference of the squares of the key numbers gives the product of the principals. Besides the explanatory text telling how to use the book for multiplying, it differs from ordinary tables of squares in being ingeniously arranged to be self-indexing. The proper page can be turned to at once and the desired number very quickly located. It gives the squares of all numbers up to 100,999.

The chief use of these tables as a means for multiplying is with numbers of five and six places. Even here it is necessary to actually write down more figures than in long-hand multiplication and the time required is about the same. For smaller numbers than five places,

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the long-hand method is quicker, though perhaps more liable to error. The Cox method requires less mental exertion and not such close attention, since the chief operations involved are addition and subtraction. In this respect the Cox tables are comparable to a table of logarithms. They are about equal in scope to a table of six-place logs., with the advantage that the products obtained are exact to the last digit without the need of interpolation.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale, and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ANALYSIS OF A THREE-LEGGED STIFF FRAME, Stressed by a Horizontal Load—By N. M. Stineman (4923 Winthrop Ave., Chicago, Ill.) [Reprint of paper presented to Western Society of Engineers, Sept. 14, 1914.] Paper; 6x9 in.; pp. 22; 11 illustrations. 25c., postpaid.

ANALYTIC GEOMETRY—By L. Wayland Dowling, Associate Professor of Mathematics, and F. E. Turneaure, Dean of the College of Engineering; University of Wisconsin. New York: Henry Holt & Co. [American Mathematical Series.] Cloth; 6x9 in.; pp. xii + 266; 140 text figures. $1.50, net.

ANNUAL REPORT OF NEW YORK STATE ENGINEER AND SURVEYOR J. A. Bensel (Albany, N. Y.), For 1913, Vol. II—Report of Bureau of Hydraulics, Department of Barge Canal, Comprising the 14th Annual Report on Stream Gaging. Cloth; 6x9 in.; pp. 458.

BOARD OF PUBLIC UTILITY COMMISSIONERS OF NEW JERSEY—Annual Report for 1913. Trenton, N. J.: Alfred N. Barber, Secretary. Paper; 6x9 in.; pp. 591.

BROOKLYN ENGINEERS' CLUB—Proceedings for 1913; Constitution and By-Laws and Annual Report of the Board of Directors. Brooklyn, N. Y.: Joseph Strachan, Secretary, 117 Remsen St. Cloth; 6x9 in.; pp. 316 illustrated. $2.

THE CLEANING OF BLAST-FURNACE GASES—By Frederick H. Wagner, M. Am. Soc. M. E. New York and London: McGraw-Hill Book Co,, Inc. Cloth; 6x9 in.; pp. 168; 58 text figures. $2, net.

CO-ORDINATION IN ENGINEERING INSTRUCTION—By A. B. McDaniel, Assistant Professor of Civil Engineering, University of Illinois. [Reprinted from the Bulletin of the Society for the Promotion of Engineering Education, Vol. IV., No. 10, 1914.] Paper; 6x9 in.; pp. 12.

THE COURSE IN CIVIL ENGINEERING—By C. J. Tilden, Professor in Civil Engineering, Johns Hopkins University, Washington, D. C. [Reprinted from the Johns Hopkins Alumni Magazine, Vol. II, No. 4, June, 1914.] Paper; 6x9 in.; pp. 8; illustrated.

THE DEPOSITS OF THE USEFUL MINERALS AND ROCKS; Their Origin, Form and Content—By Prof. Dr. F. Beyschlag, Geh. Bergrat, Direktor der Kgl. Geolog. Landesanstalt, Berlin; Prof. J. H. L. Vogt, an der Universität, Kristiania, and Prof. Dr. P. Krusch, Abteilungsdirigent a. d. Kgl. Geolog. Landesanstalt u. Dozent a.d. Kgl. Bergakademie, Berlin. Translated by S. J. Truscott, Associate Royal School of Mines, London. In Three Volumes. Vol. I, Ore-Deposits in General—Magmatic Segregations—Contact-Deposits—Tin Lodes—Quicksilver Lodes. London: Macmillan & Co., Ltd. New York: The Macmillan Co. Cloth; 6x9 in.; pp. xxviii + 514; 291 illustrations. $5, net.

THE DIAPHRAGM METHOD FOR THE MEASUREMENT OF WATER IN OPEN CHANNELS OF UNIFORM CROSS-SECTION—By Carl Robert Weidner, Instructor in Hydraulic Engineering, University of Wisconsin. Bulletin 672. Madison, Wis.: The University of Wisconsin Engineering Experiment Station. Paper; 6x9 in.; pp. 72; illustrated. 25c.

ELEMENTARY MATHEMATICAL ANALYSIS: A Text Book for First Year College Students—By Charles S. Slichter, Professor of Applied Mathematics, University of Wisconsin. [Modern Mathematical Texts.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. xiv + 490; 183 text illustrations. $2.50, net.

THE ELEMENTS OF ELECTRICITY AND MAGNETISM: A Text-Book for Colleges and Technical Schools—By Wm. S. Franklin and Barry MacNutt. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 6x9 in.; pp. viii + 351; 257 text illustrations. $1.25, net.

EXPERIMENTS: Book 1. Selected, grouped and graded experiments which may be repeated in a simple manner, including some of the most brilliant demonstrations in science, physics, chemistry, electricity, wireless communication and mechanics. Book 2. The principles of original experimenting in science, invention and the industries, together with chapters on industrial testing and commercial experiments. By Philip E. Edelman, author "Experimental Wireless Stations," etc. Minneapolis, Minn.: The Author. Cloth; 5x8 in.; pp. 256; illustrated. $1.50.

THE EXPRESS SERVICE AND RATES—By W. H. Chandler, Assistant Manager, Traffic Bureau, The Merchants' Association of New York. Chicago: LaSalle Extension University. Cloth; 6x9 in.; pp. v + 340. $3.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000: 1913. Washington, D. C.: Bureau of the Census. Bulletin 126. Paper; 9x12 in.; pp. 73.

HANDBOOK OF CONSTRUCTION PLANT; Its Cost and Efficiency—By Richard T. Dana, M. Am. Soc. C. E., M. Am. Inst. M. E., Consulting Engineer. Chicago: Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Flexible leather; 5x8 in.; pp. 702; 312 illustrations. $5.

HIGH-POWER GAS ENGINES—By H. Dubbel. Translated from the German, and Edited and Expanded so as to Include British Engines and British Practice by F. Weinreb. New York: D. Van Nostrand Co. Cloth; 7x11 in.; pp. xii + 197; 423 illustrations and 13 folding plates. $5, net.

THE ILLINOIS RIVER; Physical Relations and the Removal of the Navigation Dams, With Supplement on the Waterway Relations of the Sanitary and Ship Canal of Chicago—By Lyman E. Cooley, Consulting Engineer (Chicago, Ill.) Paper; 6x9 in.; pp. 121; illustrated.

MECHANICS OF MATERIALS—By Mansfield Merriman, M. Am. Soc. C. E. 11th Edition. New York: John Wiley & Sons, Inc., London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 524; 188 illustrations. $4, net.

METALLURGY: A Condensed Treatise for the Use of College Students and Any Desiring a General Knowledge of the Subject—By Henry Wysor, Professor of Metallurgy, Lafayette College. Second edition. Easton, Penn: The Chemical Publishing Co. London: Williams & Norgate. Cloth; 6x9 in.; pp. xiii + 391; 104 illustrations. $3.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK—Proceedings for 1913. Edited by W. H. Roberts, Chairman, Publication and Library Committee. New York: The Municipal Engineers, 29 W. 39th St. Cloth; 6x9 in.; pp. 445; illustrated.

OPINIONS AND DECISIONS OF THE RAILROAD COMMISSION OF WISCONSIN—Vol. XI., Nov. 13, 1912, to May 19, 1913. Compiled by L. E. Gettle, Secretary, Madison, Wis. Cloth; 6x9 in.; pp. 889.

PLANE TRIGONOMETRY, With Tables—By Claude Irwin Palmer and Charles Wilbur Leigh, Associate Professors of Mathematics, Armour Institute of Technology. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 132; 114 illustrations. $1.50, net.

THE POLYTECHNIC ENGINEER For 1914—Published annually by the Students of the Polytechnic Institute of Brooklyn, N. Y. Volume XIV. Cloth; 6x9 in.; pp. 164; illustrated.

PRINCIPLES OF ELECTRICAL MEASUREMENTS—By Arthur Whitmore Smith, Junior Professor of Physics, University of Michigan. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp, xiv + 243; 99 text illustrations. $2, net.

THE PRINCIPLES OF IRRIGATION PRACTICE—By John A. Widtsoe, President of the Utah Agricultural College. New York: The Macmillan Co. London: Macmillan & Co., Ltd. [The Rural Text-Book Series.] Cloth; 5x8 in.; pp. xxv + 496; 179 illustrations. $1.75, net.

PUBLIC BATH HOUSES—By Dr. Wm. Paul Gerhard, Consulting Sanitary Expert, Forty-Second St. Bldg., New York City. [Paper read before the American Association for Promoting Hygiene and Public Baths, at Newark, N. J., May 12, 1914.] Paper; 6x9 in.; pp. 29. 25c.

REPORT OF THE (VICTORIA) SLUDGE ABATEMENT BOARD, For 1913—Melbourne, Australia: E. H. Goodenough, Secretary. Paper; 8x13 in.; pp. 21; illustrated.

RURAL IMPROVEMENT; The Principles of Civic Art Applied to Rural Conditions, including Village Improvement and the Betterment of the Open Country—By Frank A. Waugh. New York: Orange Judd Co. London: Kegan Paul, Trench Trübner & Co., Ltd. Cloth; xi + 265; illustrated. $1.25, net.

THE SCIENCE AND PRACTICE OF MANAGEMENT—By A. Hamilton Church. [Works Management Library.] New York: The Engineering Magazine Co. Cloth; 5x8 in.; pp. xviii + 535; illustrated by charts. $2.

STANDARD METHODS OF GAS TESTING—Circular 48. Washington, D. C.: Bureau of Standards. Paper; 7x10 in.; pp. 180; illustrated.

TEXT-BOOK OF MECHANICS—By Louis A. Martin, Jr., Professor of Mechanics, Stevens Institute of Technology. Vol. V., Hydraulics. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xii + 223; 114 text figures. $1.50, net.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY, Vol. XVI., Containing Papers Read at Meeting Held at Wheeling, W. Va., Feb. 24-27, 1914, Together with Supplementary Discussions and Other Matters. Columbus, Ohio: Edward Orton, Jr., Secretary. Paper; 6x9 in.; pp. 611: illustrated.

TRIGONOMETRY, With the Theory and Use of Logarithms—By Maxime Böcher, Professor of Mathematics, Harvard University, and Harry Davis Gaylord, Mathematical Master in Browne and Nichols School, Cambridge. New York: Henry Holt & Co. Cloth; 5x8 in.; ix + 142; 58 text figures. $1.

U. S. BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; illustrated.

Report of the Committee on Resuscitation from Mine Gases—By W. B. Cannon, George W. Crile, Joseph Erlanger, Yandell Henderson and S. T. Meltzer. Technical Paper 77. Pp. 36.

The Origin of Coal—By David White and Reinhardt Thiessen, with a Chapter on the Formation of Peat by Charles A. Davis. Bulletin 38. Pp. 390.